SMC® Networks

MANAGEMENT GUIDE

TigerAccess™ Extended Ethernet Switch

SMC7824M/VSW

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1 Introduction

1.1 Audience

This manual is intended for Ethernet/IP DSLAM operators and maintenance personnel for providers of Digital Subscriber Line(DSL) and Ethernet services. This manual assumes that you are familiar with the following:

- Ethernet networking technology and standards
- Internet topologies and protocols
- DSL technology and standards
- Usage and functions of graphical user interfaces.

1.2 Document Structure

Tab. 1.1 briefly describes the structure of this document.

Chapter	Description
1 Introduction	Introduces the overall information of the document.
2 System Overview	Introduces the switch system. It also lists the features of the system.
3 Command Line Interface (CLI)	Describes how to use the Command Line Interface (CLI).
4 System Connection and IP Address	Describes how to manage the system account and IP address.
5 Port Configuration	Describes how to configure the Ethernet or VDSL ports.
6 System Environment	Describes how to configure the system environment and management functions.
7 Network Management	Describes how to configure the network management functions.
8 System Main Functions	Describes how to configure the system main functions.
9 IP Multicast	Describes how to configure the IP multicast functions.
10 System Software Upgrade	Describes how to upgrade the system software.
11 Abbreviations	Lists all abbreviations and acronyms which appear in this document.

Tab. 1.1 Overview of Chapters

1.3 Document Convention

This guide uses the following conventions to convey instructions and information.

Information

This information symbol provides useful information when using commands to configure and means reader take note. Notes contain helpful suggestions or references.

Warning

This warning symbol means danger. You are in a situation that could cause bodily injury or broke the equipment. Before you work on any equipment, be aware of the hazards involved with electrical circuitry and be familiar with standard practices for preventing accidents by making quick guide based on this guide.

1.4 Document Notation

The following table shows commands used in guide book. Please be aware of each command to use them correctly.

Notation	Description
a	Commands you should use as is.
NAME, PROFILE, VALUE, …	Variables for which you supply values.
PORTS	For entry this variable, see Section 5.1.
[ ]	Commands or variables that appear within square brackets [ ] are optional.
< >	Range of number that you can use.
{ }	A choice of required keywords appears in braces { }. You must select one.
|	Optional variables are separated by vertical bars |.

Tab. 1.2 Command Notation of Guide Book

1.5 Virus Protection

To prevent a virus infection you may not use any software other than that which is released for the Operating System (OS based on Basis Access Integrator), Local Craft Terminal (LCT) and transmission system.

Even when exchanging data via network or external data media(e.g. floppy disks) there is a possibility of infecting your system with a virus. The occurrence of a virus in your system may lead to a loss of data and breakdown of functionality.

The operator is responsible for protecting against viruses, and for carrying out repair procedures when the system is infected.

You have to do the following:

- You have to check every data media (used data media as well as new ones) for virus before reading data from it.
- You must ensure that a current valid virus scanning program is always available. This program has to be supplied with regular updates by a certified software.
- It is recommended that you make periodic checks against viruses in your OS.
- At the LCT it is recommended to integrate the virus scanning program into the startup sequence.

1.6 CE Declaration of Conformity

The CE declaration of the product will be fulfilled if the construction and cabling is undertaken in accordance with the manual and the documents listed there in, e.g. mounting instructions, cable lists where necessary account should be taken of project-specific documents.

Deviations from the specifications or unstipulated changes during construction, e.g. the use of cable types with lower screening values can lead to violation of the CE requirements. In such case the conformity declaration is invalidated and the responsibility passes to those who have caused the deviations.

This is a class A product. In a domestic environment this product may cause radio reference in which case the user may be required to take adequate measures.

2 System Overview

The switch, which is IP VDSL, uses VDSL (Very high-data rate Digital Subscriber Line) technologies so that users can be served voice communication and data communication at the same time through existing telephone line. Since VDSL technology takes the telephone line, you do not need to install LAN line newly. Therefore, you can save the cost and provide advanced service for users in apartments, buildings, and hotels.

The switch supports maximum 100Mbps of upload and 100Mbps down load in case of Symmetric, and up to 50 Mbps of upload and 100 Mbps of download or 10VLR Mbps of upload 50VLR Mbps of download in case of Asymmetric.

The switch offers 24-Port VDSL2 service interface and fixed 2-Port 10/100/1000Base-T and 1-slot for option uplink module. Note – The uplink module is not used in the first release.

Managed switches, as IP-VDSL of Layer 2 switch, supports VLAN, Rate limit, port trunking, port mirroring, IGMP snooping, and packet filtering.

Fig. 2.1 shows the front view of the switch.

Fig. 2.1 The front view of switch

2.1 System Features

The following introduces the main features of the VDSL2 system which provides Layer 2 switching, Ethernet switching and related functions.

Virtual Local Area Network (VLAN)

Virtual local area network (VLAN) is made by dividing one network into several logical networks. Packet cannot be transmitted and received between different VLANs. Therefore, it can prevent needless packets accumulating and strengthen security. The switch recognizes 802.1Q tagged frame and supports maximum 4096 VLANs. Port based, Protocol based, MAC based and Subnet based VLANs are supported in the switch.

Quality of Service (QoS)

For the switch, QoS-based forwarding sorts traffic into a number of classes and marks the packets accordingly. Thus, different quality of service is provided to each class, which the packets belong to. The rich QoS capabilities enable network managers to protect mission-critical applications and support differentiated level of bandwidth for managing traffic congestion. The switch supports ingress and egress (shaping) rate limiting, and different scheduling type such as SP (Strict Priority) and DWRR (Weighted Deficit Round Robin).

IP Multicast

Because broadcasting in a LAN is restricted if possible, multicasting could be used instead of broadcasting by forwarding multicast packets only to the member hosts who joined multicast group. The switch provides IGMPv2 and IGMP snooping for host membership management.

SNMP

Simple network management protocol (SNMP) is to manage Network Elements using TCP/IP protocol. The switch supports SNMP version 1, 2, 3 and Remote Monitoring (RMON). Network operator can use MIB also to monitor and manage the switch.

Dynamic Host Configuration Protocol (DHCP)

The switch supports Dynamic Host Configuration Protocol (DHCP) server that automatically assigns IP address to clients accessed to network. That means it has IP address pool, and operator can effectively utilize limited IP source by leasing temporary IP address. In layer 3 network, DHCP request packet can be sent to DHCP server via DHCP relay and option 82.

Spanning Tree Protocol (STP)

To prevent loop and preserve backup route in Layer 2 network, the switch supports spanning tree protocol (STP) defined in IEEE 802.1D. Between STP enabled switches, a root bridge is automatically selected and the network remains in tree topology. But the recovery time in STP is very slow (about 30 seconds), rapid spanning tree protocol (RSTP) is also provided. IEEE 802.1w defines the recovery time as 2 seconds. If there is only one

VLAN in the network, traditional STP works. However in more than one VLAN network, STP cannot work per VLAN. To avoid this problem, the switch supports multiple spanning tree protocol (MSTP) IEEE 802.1s.

Trunking & Link Aggregation Control Protocol (LACP)

The switch aggregates several physical interfaces into one logical port (aggregate port). Port trunk aggregates interfaces with the standard of same speed, same duplex mode, and same VLAN ID.

The switch supports link aggregation control protocol (LACP), complying with IEEE 802.3ad, which aggregates multiple links of equipments to use more enlarged bandwidth.

System Management based on CLI

It is easy for users who administer system by using telnet or console port to configure the functions for system operating through CLI. CLI is easy to configure the needed functions after looking for available commands by help menu different with UNIX.

Broadcast Storm Control

Broadcast storm control is, when too much of broadcast packets are being transmitted to network, a situation of network timeout because the packets occupy most of transmit capacity. switch supports broadcast and multicast storm control, which disuses flooding packet, that exceed the limit during the time configured by user.

Outband Management Interface

The switch can connect to equipments at remote place by assigning IP address to MGMT interface. Since MGMT interface is operated regardless of status of service port, it is still possible to configure and manage equipment at remote place.

RADIUS and TACACS+

The switch supports client authentication protocol, that is RADIUS (Remote Authentication Dial-In User Service) and TACACS+ (Terminal Access Controller Access Control System Plus). Not only user IP and password registered in switch but also authentication through RADIUS server and TACACS+ server are required to access. So security of system and network management is strengthened.

Secure Shell (SSH)

Network security is getting more important because the access network has been generalized among numerous users. Secure shell (SSH) is a network protocol that allows establishing a secure channel between a local and a remote computer. It uses public-key cryptography to authenticate the remote computer and to allow the remote computer to authenticate the user.

3 Command Line Interface (CLI)

The switch enables system administrators to manage the switch by providing the command line interface (CLI). This user-friendly CLI provides you with a more convenient management environment.

To manage the system with the CLI, a management network environment is required. The switch can connect to the management network either directly (outband) or through the access network (inband). It can even connect using a combination of the two; for example, a cascaded switch connects inband to the cascading switch, and then from the cascading switch to the management network through the outband interface.

The switch also provides the RS232 console interface to simply access the system with a provided RJ45-to-DB9 cable.

This chapter describes a basic instruction for using the command line interface (CLI) which is used for managing the system.

- Configuration Mode
- Configuration Mode Overview
- Useful Tips

3.1 Configuration Mode

You can configure and manage the switch with the CLI via a management network environment or the console interface.

The CLI provides the following command modes:

- Privileged EXEC View Mode
- Privileged EXEC Enable Mode
- Global Configuration Mode
- Bridge Configuration Mode
- DHCP Pool Configuration Mode
- DHCP Option 82 Configuration Mode
- Interface Configuration Mode
- Rule Configuration Mode
- RMON Configuration Mode

3.1.1 Privileged EXEC View Mode

When you log in to the switch, the CLI will start with *Privileged EXEC View* mode which is a read-only mode. In this mode, you can see a system configuration and information with several commands.

Tab. 3.1 shows main command of *Privileged EXEC View* mode.

Command	Description
enable	Opens *Privileged EXEC Enable* mode.
exit	Logs out the switch.
show	Shows a system configuration and information.

Tab. 3.1 Main Command of *Privileged EXEC View* Mode

3.1.2 Privileged EXEC Enable Mode

To configure the switch, you need to open *Privileged EXEC Enable* mode with the **enable** command, then the system prompt will changes from SWITCH> to SWITCH#.

Command	Mode	Description
enable	View	Opens *Privileged EXEC Enable* mode.

You can set a password to *Privileged EXEC Enable* mode to enhance security. Once setting a password, you should enter a configured password, when you open *Privileged EXEC Enable* mode.

Tab. 3.2 shows main commands of *Privileged EXEC Enable* mode.

Command	Description
clock	Sets a system time and date.
configure terminal	Opens *Global Configuration* mode.
reload	Reboots the system.
telnet	Connects to a remote host through telnet.
terminal length	Configures the number of lines of the current terminal.
traceroute	Traces a packet route.
where	Displays users accessing the system via telnet or console.

Tab. 3.2 Main Command of *Privileged EXEC Enable* Mode

3.1.3 Global Configuration Mode

In *Global Configuration* mode, you can configure general functions of the system. You can also open another configuration mode from this mode.

To open *Global Configuration* mode, enter the **configure terminal** command, and then the system prompt will be changed from SWITCH# to SWITCH(config)#.

Command	Mode	Description
configure terminal	Enable	Opens *Global Configuration* mode.

Tab. 3.3 shows main commands of *Global Configuration* mode.

Command	Description
bridge	Opens *Bridge Configuration* mode.
dns	Sets a DNS server.
dot1x	Configures 802.1X authentication.
exec-timeout	Sets an auto log-out timer.
help	Shows a description of the interactive help system.
hostname	Sets a host name of the system.
interface	Opens *Interface Configuration* mode to configure a specified interface.
mvr	Configures MVR.
ntp	Configures NTP.
passwd	Sets a system password.
qos	Configures QoS.
rmon-alarm	Opens *RMON Configuration* mode to configure RMON alarm.
snmp	Configures SNMP.
ssh	Configures SSH.
stack	Configures a system stacking.
syslog	Configures a syslog.
threshold	Sets a system threshold.

Tab. 3.3 Main Command of *Global Configuration* Mode

3.1.4 Bridge Configuration Mode

In *Bridge Configuration* mode, you can configure various Layer 2 functions such as VLAN, STP, LACP, EFM OAM, etc.

To open *Bridge Configuration* mode, enter the **bridge** command, then the system prompt will be changed from SWITCH(config)# to SWITCH(bridge)#.

Command	Mode	Description
bridge	Global	Opens *Bridge Configuration* mode.

Tab. 3.4 shows main commands of *Bridge Configuration* mode.

Command	Description
lacp	Configures LACP.
mac	Configures a MAC table.
mirror	Configures a port mirroring.
oam	Configures EFM OAM.
port	Configures Ethernet port.
spanning-tree	Configures Spanning Tree Protocol (STP).
trunk	Configures a trunk port.
vlan	Configures VLAN.

Tab. 3.4 Main Command of *Bridge Configuration* Mode

3.1.5 DHCP Pool Configuration Mode

In *DHCP Pool Configuration* mode, you can configure general functions of DHCP per each DHCP pool. The switch supports multiple DHCP environments with this pool based DHCP configuration.

To open *DHCP Pool Configuration* mode, enter the **ip dhcp pool** command, then the system prompt will be changed from SWITCH(config)# to SWITCH(config-dhcp[POOL])#.

Command	Mode	Description
ip dhcp pool *POOL*	Global	Opens *DHCP Pool Configuration mode* to configure DHCP.

To open *DHCP Pool Configuration* mode, use the **service dhcp** command in the *Global Configuration* mode first!

Tab. 3.5 shows main commands of *DHCP Pool Configuration* mode.

Command	Description
default-router	Configures the default gateway of the pool.
dns-server	Configures a DNS server.
range	Configures the range of IP addresses.

Tab. 3.5 Main Command of *DHCP Pool Configuration* Mode

3.1.6 DHCP Option Configuration Mode

In *DHCP Option Configuration* mode, you can configure DHCP option. You can define DHCP options that are carried in the DHCP communication between DHCP server and client or relay agent. A specific DHCP option can be defined by its format type, length and value.

To open *DHCP Option Configuration* mode, use the command. Then the system prompt will be changed from SWITCH(config)# to SWITCH(dhcp-opt[NAME])#.

Command	Mode	Description
ip dhcp option format *NAME*	Global	Opens *DHCP Option Configuration* mode to configure DHCP options.

Tab. 3.7 is the main commands of *DHCP Option Configuration* mode.

Command	Description
attr	Configures the attribute for option field in the DHCP packet.

Tab. 3.6 Main Command of *DHCP Option Configuration* Mode

3.1.7 DHCP Option 82 Configuration Mode

In *DHCP Option 82 Configuration* mode, you can configure DHCP option 82 for DHCP relay agent. This feature enables network administrators to manage IP resources more efficiently.

To open *DHCP Option 82 Configuration* mode, enter the **ip dhcp option82** command, then the system prompt will be changed from SWITCH(config)# to SWITCH(config-opt82)#.

Command	Mode	Description
ip dhcp option82	Global	Opens *DHCP Option 82 Configuration* mode to configure DHCP option 82.

To open *DHCP Option 82 Configuration* mode, use the **service dhcp** command in the *Global Configuration* mode first!

Tab. 3.7 is the main commands of *DHCP Option 82 Configuration* mode.

Command	Description
policy	Configures the policy for option 82 field in the DHCP packet.
system-remote-id	Configures a system remote ID.
system-circuit-id	Configures a system circuit ID.
trust	Configures a option82 packet of policy

Tab. 3.7 Main Command of *DHCP Option 82 Configuration* Mode

3.1.8 Interface Configuration Mode

In *Interface Configuration* mode, you can configure Ethernet interfaces. To open *Interface Configuration* mode, enter the **interface** command, then the system prompt will be changed from SWITCH(config)# to SWITCH(config-if)#.

Command	Mode	Description
interface *INTERFACE*	Global	Opens *Interface Configuration* mode.

Tab. 3.8 shows main commands of *Interface Configuration* mode.

Command	Description
description	Specifies a description.
ip address	Assigns IP address.
shutdown	Deactivates an interface.
mtu	Sets MTU value.

Tab. 3.8 Main Command of *Interface Configuration* Mode

3.1.9 Rule Configuration Mode

The switch modifies previous *Rule Configuration* mode to *Flow, Policer* and *Policy Configuration* modes. Rule configuration mode is expanded into three different modes according to its roles for Rule mechanism. You can configure a rule for incoming or outgoing packets. Using the function, you can handle packets classified by the rule.

To open *Rule Configuration* mode, enter the **flow, policer and policy** commands, then the system prompt will be changed from SWITCH(config)# to SWITCH(config-flow[NAME])#, SWITCH(config-policer[NAME])# and SWITCH(config-policy[NAME])# .

Command	Mode	Description
flow *NAME* **create**	Global	Opens *Flow Configuration* mode.
policer *NAME* **create**		Opens *Policer Configuration* mode.
policy *NAME* **create**		Opens *Policy Configuration* mode.

Tab. 3.9 shows the commands of *Rule Configuration* mode.

Command	Description
cos	Classifies an IEEE 802.1p priority.
mac	Classifies a MAC address.
action match	Configures a rule action for classified packets.
rate-limit	Comfigures a rate-limit of classified packets
priority	Configures a rule priority of specified policy.

Tab. 3.9 The Commands of *Rule Configuration* Mode

3.1.10 RMON Configuration Mode

In *RMON Configuration* mode, you can configure RMON alarm, RMON event and RMON history. The switch provides three different configuration modes to configure each type of RMON.

Command	Mode	Description
rmon-alarm <1-65535>	Global	Opens *RMON Configuration* mode. 1-65535: index number
rmon-event <1-65535>		
rmon-history <1-65535>		

Tab. 3.10 shows main commands of *RMON Configuration* mode.

Command	Description
active	Activates RMON.
owner	Shows the subject which configures each RMON and uses relevant information.

Tab. 3.10 Main Command of *RMON Configuration* Mode

3.2 Configuration Mode Overview

Fig. 3.1 shows the overview of the configuration mode for the switch.

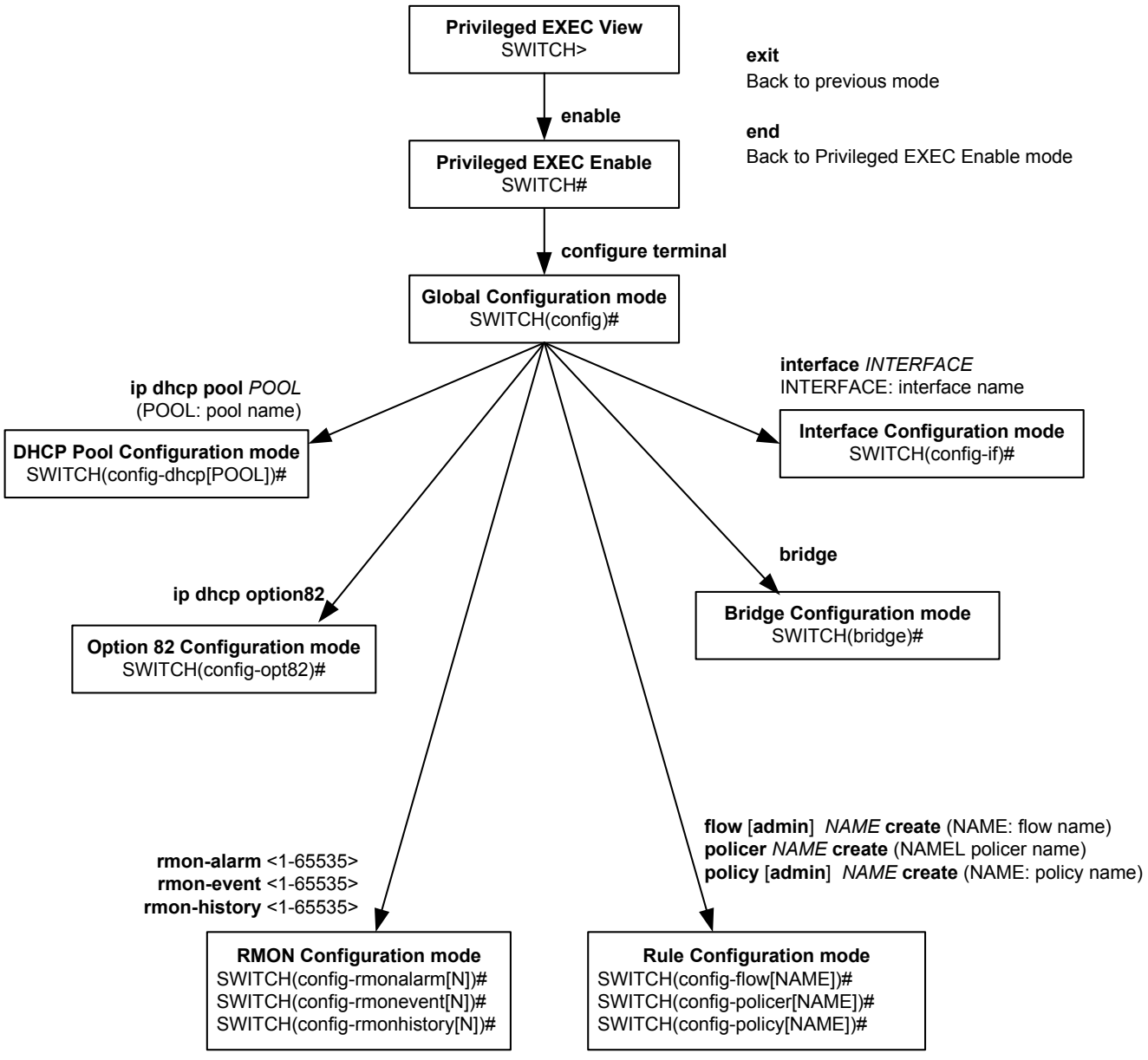


Fig. 3.1 Overview of Configuration Mode

3.3 Useful Tips

This section describes useful tips for operating the switch with a CLI.

- Listing Available Command
- Calling Command History
- Using Abbreviation
- Using Command of Privileged EXEC Enable Mode
- Exit Current Command Mode

3.3.1 Listing Available Command

To list available commands, input question mark <**?**> in the current mode. When you input the question mark <**?**>, you can see available commands used in this mode and variables following after the commands.

The following is the available commands on *Privileged EXEC Enable* mode of the switch.

```
SWITCH# ?
Exec commands:
  clear          Reset functions
  clock          Manually set the system clock
  configure      Enter configuration mode
  copy           Copy from one file to another
  debug          Debugging functions
  default-os     Select default OS
  disconnect     Disconnect user connection
  enable         Turn on privileged mode command
  erase          Erase saved configuration
  exit           End current mode and down to previous mode
  halt           Halt process
  help           Description of the interactive help system
  no             Negate a command or set its defaults
  ping           Send echo messages
  quote          Execute external command
  rcommand       Management stacking node
  release        Release the acquired address of the interface

(Omitted)

SWITCH#
```

Question mark <**?**> will not be shown in the screen and you do not need to press <**ENTER**> key to display the command list.

If you need to find out the list of available commands of the current mode in detail, use the following command.

Command	Mode	Description
show list	All	Shows available commands of the current mode.
show cli		Shows available commands of the current mode with tree structure.

The following is an example of displaying the list of available commands of *Privileged EXEC Enable* mode.

```
SWITCH# show list
  clear arp
  clear arp IFNAME
  clear cpe stat-error (PORTS|)
  clear ip arp inspection statistics (vlan VLAN_NAME|)
  clear ip dhcp authorized-arp invalid
  clear ip dhcp leasedb A.B.C.D/M
  clear ip dhcp leasedb all
  clear ip dhcp leasedb pool POOL
  clear ip dhcp relay statistics
  clear ip dhcp statistics
  clear ip igmp
  clear ip igmp group *
  clear ip igmp group A.B.C.D
  clear ip igmp group A.B.C.D IFNAME
  clear ip igmp interface IFNAME
  clear ip igmp snooping stats port (PORTS|cpu|)
  clear ip kernel route
  clear ip mcfdb (*|vlan VLAN)
  clear ip mcfdb vlan VLAN group A.B.C.D source A.B.C.D
  clear ip route kernel
  clear lacp statistic
  clear lldp statistics (PORTS|)
  clear lre error-stat-all (PORTS|)

-- more --
```

i Press the <**ENTER**> key to skip to the next list.

In case that the switch installed command shell, you can find out commands starting with a specific alphabet. Input the first letter and question mark without space. The following is an example of finding out the commands starting "**s**" in *Privileged EXEC Enable* mode of the switch.

```
SWITCH# s?
show          Show running system information
ssh           Configure secure shell

SWITCH# s
```

Also, it is possible to view variables you should input following after commands. After inputting the command you need, make one space and input a question mark. The following is an example of viewing variables after the **write** command. Please note that you must input one space between the command and question mark.

```
SWITCH# write ?
memory       Write to NV memory
terminal     Write to terminal

SWITCH# write
```

The switch also provides the simple instruction of calling the help string with the **help** command. You can see the instruction using the command regardless of the configuration mode.

To display the instruction of calling the help string for using CLI, use the following command.

Command	Mode	Description
help	All	Shows the instruction of calling the help string for using CLI.

3.3.2 Calling Command History

In case of installed command shell, you do not have to enter the command you entered before. When you need to reuse the commands you did, use this arrow key <↑>. When you press the arrow key, the commands will be displayed in the latest order.

The following is an example of calling command history after using several commands. After using these commands in order: **show clock** → **configure terminal** → **interface** *1* → **exit**, press the arrow key <↑> and then you will see the commands from latest one: **exit** → **interface** *1* → **configure terminal** → **show clock**.

```
SWITCH(config)# exit
SWITCH# show clock
Mon, 5 Jan 1970 23:50:12 +0000
SWITCH# configure terminal
SWITCH(config)# interface 1
SWITCH(config-if)# exit
SWITCH(config)# exit
SWITCH# (press the arrow key ↑)
SWITCH# exit (press the arrow key ↑)
SWITCH# interface 1 (press the arrow key ↑)
SWITCH# configure terminal (press the arrow key ↑)
SWITCH# show clock (press the arrow key ↑)
```

The switch also provides the command that shows the commands used before up to 100 lines.

Command	Mode	Description
show history	Enable Global Bridge	Shows a command history.

3.3.3 Using Abbreviation

Several commands can be used in the abbreviated form. The following table shows some examples of abbreviated commands.

Command	Abbreviation
clock	cl
exit	ex
show	sh
configure terminal	con te

Tab. 3.11 Command Abbreviation

3.3.4 Using Command of Privileged EXEC Enable Mode

You can execute the commands of *Privileged EXEC Enable* mode as **show**, **ping**, **telnet**, **traceroute**, and so on regardless of which mode you are located on.

To execute the commands of *Privileged EXEC Enable* mode on different mode, use the following command.

Command	Mode	Description
do *COMMAND*	All	Executes the commands of *Privileged EXEC Enable* mode.

3.3.5 Exit Current Command Mode

To exit to the previous command mode, use the following command.

Command	Mode	Description
exit	All	Exits to the previous command mode.
end		Exits to *Privileged EXEC Enable* mode.

If you use the **exit** command in *Privileged EXEC Enable* mode or *Privileged EXEC View* mode, you will be logged out!

4 System Connection and IP Address

4.1 System Connection

After installing the system, the switch is supposed to examine that each port is rightly connected to network and management PC. You can connect to the system to configure and manage the switch. This section provides instructions how to change password for system connection and how to connect to the system through telnet as the following order.

- Connecting to the Console Port
- System Login
- Password for Privileged EXEC Enable Mode
- Changing Login Password
- Login Password Recovery Process
- Management for System Account
- Limiting Number of Users
- Auto Log-out
- Telnet Access
- System Rebooting

4.1.1 Connecting to the Console Port

To begin setup, you must connect the Console to the RJ45 Console port. To connect the cable, perform the following steps:

Step 1 Attach the RJ45 connector on the cable to the RJ45 connector on the console port of the switch.

Step2 Connect the other end of the cable to one of the serial ports on your workstation.

Step3 Open your terminal emulation software and configure the COM port settings to which you have connected the cable. The settings should be set to match the default settings for the switch, which are:

- 9600 bps
- 8 data bits
- 1 stop bit
- No parity
- No flow control

4.1.2 System Login

After installing the switch, finally make sure that each port is correctly connected to PC for network and management. And then, turn on the power and boot the system as follows.

Step 1
When you turn on the switch, booting will be automatically started and login prompt will be displayed.

```
SWITCH login:
```

Step 2
When you enter a login ID at the login prompt, the password prompt will be displayed, and then enter the proper password to log in the system. By default setting, the login ID is configured as *admin* with no password.

```
SWITCH login: admin
Password:
SWITCH>
```

Step 3
In *Privileged EXEC View* mode, you can check only the configuration for the switch. To configure and manage the switch, you should begin *Privileged EXEC Enable* mode. The following is an example of beginning *Privileged EXEC Enable* mode.

```
SWITCH> enable
SWITCH#
```

4.1.3 Password for Privileged EXEC Enable Mode

You can configure a password to enhance the security for *Privileged EXEC Enable* mode. To configure a password for *Privileged EXEC Enable* mode, use the following command.

Command	Mode	Description
passwd enable *PASSWORD*	Global	Configures a password to begin *Privileged EXEC Enable* mode.
passwd enable 8 *PASSWORD*		Configures an encrypted password.

password enable does not support encryption at default value. Therefore it shows the string (or password) as it is when you use the **show running-config** command. In this case, the user's password is shown to everyone and has unsecured environment.

To encrypt the password which will be shown at running-config, you should use the **service password-encryption** command. And to represent the string (password) is encrypted, input **8** before the encrypted string.

When you use the **password enable** command with **8** and "the string", you will make into *Privileged EXEC Enable* mode with the encrypted string. Therefore, to log in the system, you should do it with the encrypted string as password that you configured after **8**. In short, according to using the **8** option or not, the next string is encrypted or not.

The following is an example of configuring the password in *Privileged EXEC Enable* mode as *testpassword*.

```
SWITCH# configure terminal
SWITCH(config)# passwd enable testpassword
SWITCH(config)#
```

The following is an example of accessing after configuring a password.

```
SWITCH login: admin
Password:
SWITCH> enable
```

```
Password:
SWITCH#
```

To delete the configured password, use the following command.

Command	Mode	Description
no passwd enable	Global	Deletes the password.

The created password can be displayed with the **show running-config** command. To encrypt the password not to be displayed, use the following command.

Command	Mode	Description
service password-encryption	Global	Encrypts the system password.

To disable password encryption, use the following command.

Command	Mode	Description
no service password-encryption	Global	Disables password encryption.

4.1.4 Changing Login Password

To configure a password for created account, use the following command.

Command	Mode	Description
passwd [*NAME*]	Global	Configures a password for created account.

The following is an example of changing the current password.

```
SWITCH(config)# passwd
Changing password for admin
Enter the new password (minimum of 5, maximum of 8 characters)
Please use a combination of upper and lower case letters and numbers.
Enter new password:junior95
Re-enter new password:junior95
Password changed.
SWITCH(config)#
```

The password you are entering will not be shown in the screen, so please be careful not to make a mistake.

4.1.5 Login Password Recovery Process

To upgrade the system software in the boot mode, perform the following step-by-step instruction:

Step 1
After the switch is manually restarted, "`Start Address: 0x010000000`" will be shown up.

Step 2
Keep on pressing [**Space Bar**] key until "`console=ttyS0,9600 root=/dev/ram rw`" is shown up on the screen.

Step 3
Enter "**password**" next to "`console=ttyS0,9600 root=/dev/ram rw`".

Step 4
Check "`password restore to default...`" on the booting messages. It means that the current password returns to the default setting.

Step 4
Check "`password restore to default...`" on the booting messages. It means that the current password returns to the default setting. By default setting, the password is configured as *nsn-switch*.

```
************************************************************
*                                                          *
*                 Boot Loader Version 5.43                 *
*                   SMC Networks Inc.                      *
*                                                          *
************************************************************
Press 's' key to go to Boot Mode:  0


Load Address:   0x01000000
Image Size:     0x00bac000
Start Address:  0x01000000 ------------------------------- Step 1
                                                           Step 2
console=ttyS0,9600 root=/dev/ram rw [password] ---------- Step 3
NOS version 5.01
CPU : MPC8245 at 264 MHz
Total Memory Size : 256 MB
Calibrating delay loop... 175.71 BogoMIPS
INIT: version 2.85 booting
Extracting configuration
[password restore to default..] ------------------------- Step 4

Fri, 03 Nov 2006 14:10:00 +0000
INIT: Entering runlevel: 3
INIT: Start UP

Password:
```

4.1.6 Management for System Account

4.1.6.1 Creating System Account

For the switch, the administrator can create a system account. And it is possible to set the security level from 0 to 15 to enhance the system security.

To create a system account, use the following command.

Command	Mode	Description
user add *NAME DESCRIPTION*	Global	Creates a system account. NAME: user name
user add *NAME* **level** <0-15> *DESCRIPTION*		Creates a system account with a security level. NAME: user name

The account of level 0 to level 14 without any configuring authority only can use **exit** and **help** in *Privileged EXEC View* mode and cannot access to *Privileged EXEC Enable* mode. The account with the highest level 15 has a read-write authority.

To delete the created account, use the following command.

Command	Mode	Description
user del *NAME*	Global	Delete the created account.

To display a created account, use the following command.

Command	Mode	Description
show user	Enable Global Bridge	Shows a created account.

4.1.6.2 Security Level

For the switch, it is possible to configure the security level from 0 to 15 for a system account. The level 15, as the highest level, has a read-write authority. The administrator can configure from level 0 to level 14. The administrator decides which level user uses which commands in which level. As the basic right from level 0 to level 14, it is possible to use **exit** and **help** command in *Privileged EXEC View* mode and it is not possible to access to *Privileged EXEC Enable* mode.

To define the security level and its authority, use the following command.

Command	Mode	Description
privilege view level <0-15> {*COMMAND* | **all**}	Global	Uses the specific command of *Privileged EXEC View* mode in the level.
privilege enable level <0-15> {*COMMAND* | **all**}		Uses the specific command of *Privileged EXEC Enable* mode in the level.
privilege configure level <0-15> {*COMMAND* | **all**}		Uses the specific command of *Global Configuration* mode in the level.
privilege interface level <0-15> {*COMMAND* | **all**}		Uses the specific command of *Interface Configuration* mode in the level.
privilege {**flow | policer | policy**} **level** <0-15> {*COMMAND* | **all**}		Uses the specific command of *Rule Configuration* mode in the level.
privilege bridge level <0-15> {*COMMAND* | **all**}		Uses the specific command of *Bridge Configuration* mode in the level.
privilege rmon-alarm level <0-15> {*COMMAND* | **all**}		Uses the specific command of *RMON Configuration* mode in the level.
privilege rmon-event level <0-15> {*COMMAND* | **all**}		
privilege rmon-history level <0-15> {*COMMAND* | **all**}		
privilege dhcp-pool level <0-15> {*COMMAND* | **all**}		Uses the specific command of *DHCP Pool Configuration* mode in the level.
privilege dhcp-pool-class level <0-15> {*COMMAND* | **all**}		Uses the specific command of *DHCP Pool Class Configuration* mode in the level.
privilege dhcp-option82 level <0-15> {*COMMAND* | **all**}		Uses the specific command of *DHCP Option 82 Configuration* mode in the level.
privilege dhcp-class level <0-15> {*COMMAND* | **all**}		Uses the specific command of *DHCP Class Configuration* mode in the level.

The commands that are used in low level can be also used in the higher level. For example, the command in level 0 can be used in from level 0 to level 14.

The commands should be input same as the displayed commands by **show list**. Therefore, it is not possible to input the commands in the bracket separately.

```
SWITCH# show list
  clear arp
  clear arp IFNAME
  clear cpe stat-error (PORTS|)
  clear ip arp inspection statistics (vlan VLAN_NAME|)
  clear ip dhcp authorized-arp invalid
  clear ip dhcp leasedb A.B.C.D/M
  clear ip dhcp leasedb all

(Omitted)
```

The commands starting with the same character are applied by inputting only the starting commands. For example, if you input **show**, all the commands starting with **show** are applied. To delete a configured security level, use the following command.

Command	Mode	Description
no privilege	Global	Deletes all configured security levels.
no privilege view level <0-15> {*COMMAND* | **all**}		Delete a configured security level on each mode.
no privilege enable level <0-15> {*COMMAND* | **all**}		
no privilege configure level <0-15> {*COMMAND* | **all**}		
no privilege interface level <0-15> {*COMMAND* | **all**}		
no privilege {**flow | policer | policy**} **level** <0-15> {*COMMAND* | **all**}		
no privilege bridge level <0-15> {*COMMAND* | **all**}		
no privilege rmon-alarm level <0-15> {*COMMAND* | **all**}		
no privilege rmon-event level <0-15> {*COMMAND* | **all**}		
no privilege rmon-history level <0-15> {*COMMAND* | **all**}		
no privilege dhcp-pool level <0-15> {*COMMAND* | **all**}		
no privilege dhcp-pool-class level <0-15> {*COMMAND* | **all**}		
no privilege dhcp-option82 level <0-15> {*COMMAND* | **all**}		
no privilege dhcp-class level <0-15> {*COMMAND* | **all**}		

To display a configured security level, use the following command.

Command	Mode	Description
show privilege	Enable Global Bridge	Shows a configured security level.
show privilege now		Shows a security level of current mode.

The following is an example of creating the system account *test0* having a security level 10 and *test1* having a security level 1 with no password.

```
SWITCH(config)# user add test0 level 0 level0user
Changing password for test0
Enter the new password (minimum of 5, maximum of 8 characters)
Please use a combination of upper and lower case letters and numbers.
```

```
Enter new password:(Enter)
Bad password: too short.

Warning: weak password (continuing).
Re-enter new password: (Enter)
Password changed.
SWITCH(config)# user add test1 level 1 level1user
Changing password for test1
Enter the new password (minimum of 5, maximum of 8 characters)
Please use a combination of upper and lower case letters and numbers.
Enter new password: (Enter)
Bad password: too short.

Warning: weak password (continuing).
Re-enter new password: (Enter)
Password changed.
SWITCH(config)# show user
=====================================================
 User name            Description       Level
=====================================================
test0                level0user          0
test1                level1user          1
SWITCH(config)#
```

The following is an example of configuring an authority of the security level 0 and 1.

```
SWITCH(config)# privilege view level 0 enable
SWITCH(config)# privilege enable level 0 show
SWITCH(config)# privilege enable level 1 configure terminal
SWITCH(config)# show privilege

 Command Privilege Level Configuration
 -------------------------------------------
 Node          All   Level   Command
 EXEC(ENABLE)          1     configure terminal
 EXEC(VIEW)            0     enable
 EXEC(ENABLE)          0     show

 3 entry(s) found.

SWITCH(config)#
```

In the above configuration, as level 0, it is possible to use only show command in *Privileged EXEC Enable* mode; however as level 1, it is possible to use not only the commands in level 1 but also time configuration commands in *Privileged EXEC Enable* mode and accessing commands to *Global Configuration* mode.

4.1.7 Limiting Number of Users

For the switch, you can limit the number of users accessing the switch through both console interface and telnet. In case of using the system authentication with RADIUS or TACACS+, a configured number includes the number of users accessing the switch via the authentication server.

To set the number of users accessing the switch, use the following command.

Command	Mode	Description
login connect <1-8>	Global	Sets the number of users accessing the switch. Default: 8
no login connect		Deletes a configured value.

4.1.8 Auto Log-out

For security reasons of the switch, if no command is entered within the configured inactivity time, the user is automatically logged out of the system. Administrator can configure the inactivity timer.

To enable auto log-out function, use the following command.

Command	Mode	Description
exec-timeout <1-35791> [<0-59>]	Global	Enables auto log-out. 1-35791: time unit in minutes (by default 10 minutes) 0-59: time unit in seconds
exec-timeout 0		Disables auto log-out.

To display a configuration of auto-logout function, use the following command.

Command	Mode	Description
show exec-timeout	Enable Global Bridge	Shows a configuration of auto-logout function.

The following is an example of configuring auto log-out function as 60 seconds and viewing the configuration.

```
SWITCH(config)# exec-timeout 60
SWITCH(config)# show exec-timeout
Log-out time : 60 seconds
SWITCH(config)#
```

4.1.9 Telnet Access

To connect to a remote host via telnet, use the following command.

Command	Mode	Description
telnet *DESTINATION* [*TCP-PORT*]	Enable	Connects to a remote host. DESTINATION: IP address or host name

In case of telnet connection, you need to wait for the **[OK]** message, when you save a system configuration. Otherwise, all changes will be lost when the telnet session is disconnected.

```
SWITCH# write memory
[OK]
SWITCH#
```

The system administrator can disconnect users connected from remote place. To disconnect a user connected through telnet, use the following command.

Command	Mode	Description
disconnect *TTY-NUMBER*	Enable	Disconnects a user connected through telnet.

The following is an example of disconnecting a user connected from a remote place.

```
SWITCH# where
admin at ttys0 from console for 4 days 22 hours 15 minutes 24.88 seconds
admin at ttyp0 from 10.0.1.4:1670 for 4 days 17 hours 53 minutes 28.76 seconds
admin at ttyp1 from 147.54.140.133:49538 for 6 minutes 34.12 seconds
SWITCH# disconnect ttyp0
SWITCH# where
admin at ttys0 from console for 4 days 22 hours 15 minutes 34.88 seconds
admin at ttyp1 from 147.54.140.133:49538 for 6 minutes 44.12 seconds
SWITCH#
```

4.1.10 System Rebooting

4.1.10.1 Manual System Rebooting

When installing or maintaining the system, some tasks require rebooting the system by various reasons. Then you can reboot the system with a selected system OS.

To restart the system manually, use the following command.

Command	Mode	Description
reload [**os1** | **os2**]	Enable	Restarts the system.

If you reboot the system without saving new configuration, new configuration will be deleted. So, you have to save the configuration before rebooting. Not to make that mistake, the switch reconfirms that by displying the following message to ask if user really wants to reboot and save configuration.

If you want to save the system configuration, press <**Y**> key at first question, if you want to continue to reboot the system, press <**Y**> key at second question.

The following is an example of restarting the system with the **reload** command.

```
SWITCH# reload
Do you want to save the system configuration? [y/n]
Do you want to reload the system? [y/n]
```

4.1.10.2 Auto System Rebooting

The switch reboots the system according to user's configuration. There are two basis for system rebooting. These are CPU and memory. CPU is rebooted in case CPU Load or Interrupt Load continues for the configured time. Memory is automatically rebooted in case memory low occurs as the configured times.

To enable the auto system rebooting, use the following command.

Command	Mode	Description
auto-reset cpu <50-100> <1-100> *TIME*	Bridge	Configures the system to restart automatically in case an average of CPU or interrupt load exceeds the configured value during the user-defined time. 50-100: average of CPU load 1-100: average of interrupt load
auto-reset memory <1-120> <1-10>		Configures the system to restart automatically in case memory low occurs as the configured value. 1-120: time of memory low 1-10: count of memory low
no auto-reset {**cpu** | **memory**}		Disables auto system rebooting.

To display a current configured auto system rebooting, use the following command.

Command	Mode	Description
show auto-reset cpu	Enable Global Bridge	Shows a current configured auto system rebooting by CPU.
show auto-reset memory		Shows a current configured auto system rebooting by system memory.

4.2 System Authentication

For the enhanced system security, the switch provides two authentication methods to access the switch such as Remote Authentication Dial-In User Service (RADIUS) and Terminal Access Controller Access Control System Plus (TACACS+).

4.2.1 Authentication Method

To set the system authentication method, use the following command.

Command	Mode	Description
login {**local** | **remote**} {**radius** | **tacacs** | **host** | **all**} {**enable** | **disable**}	Global	Sets a system authentication method. local: console access remote: telnet/SSH access radius: RADIUS authentication tacacs: TACACS+ authentication host: nominal system authentication (default) all: all types of the authentication
no login {**local** | **remote**} {**radius** | **tacacs** | **host** | **all**}		Deletes a configured system authentication method.
no login		

4.2.2 Authentication Interface

If more than 2 interfaces exist in the switch, you can set one interface to access RADIUS or TACACS server. To set an authentication interface, use the following command.

Command	Mode	Description
login {**radius** | **tacacs**} **interface** *INTERFACE* [*A.B.C.D*]	Global	Sets an authentication interface. radius: RADIUS authentication tacacs: TACACS+ authentication INTERFACE: interface name A.B.C.D: source IP address (optional)
no login {**radius** | **tacacs**} **interface**		Deletes a specified authentication interface.

4.2.3 Primary Authentication Method

You can set the order of the authentication method by giving the priority to each authentication method. To set the primary authentication method, use the following command

Command	Mode	Description
login {**local** | **remote**} {**radius** | **tacacs** | **host**} **primary**	Global	Sets a system authentication method. local: console access remote: telnet/SSH access radius: RADIUS authentication tacacs: TACACS+ authentication host: nominal system authentication (default)

4.2.4 RADIUS Server

4.2.4.1 RADIUS Server for System Authentication

To add/delete a RADIUS server for system authentication, use the following command.

Command	Mode	Description
login radius server *A.B.C.D KEY* [**auth_port** *PORT* **acct_port** *PORT*]	Global	Adds a RADIUS server with its information. A.B.C.D: IP address KEY: authentication key value auth_port: authentication port (optional) acct_port: accounting port (optional)
no login radius server [*A.B.C.D*]		Deletes an added RADIUS server.

i You can add up to 5 RADIUS servers.

4.2.4.2 RADIUS Server Priority

To specify the priority of a registered RADIUS server, use the following command.

Command	Mode	Description
login radius server move *A.B.C.D* <1-5>	Global	Specifies a priority of RADIUS server. A.B.C.D: IP address 1-5: priority of RADIUS server

4.2.4.3 Timeout of Authentication Request

After an authentication request, the switch waits for a response from a RADIUS server for specified time. To specify a timeout value, use the following command.

Command	Mode	Description
login radius timeout <1-100>	Global	Specifies a timeout value. 1-100: timeout value for a response (default: 5)
no login radius timeout		Deletes a specified timeout value.

4.2.4.4 Frequency of Retransmit

In case of no response from a RADIUS server, the switch is supposed to retransmit an authentication request. To set the frequency of retransmitting an authentication request, use the following command.

Command	Mode	Description
login radius retransmit <1-10>	Global	Sets the frequency of retransmit. 1-10: frequency count (default: 3)
no login radius retransmit		Deletes a specified frequency count.

4.2.5 TACACS+ Server

4.2.5.1 TACACS+ Server for System Authentication

To add/delete the TACACS+ server for system authentication, use the following command.

Command	Mode	Description
login tacacs server *A.B.C.D KEY*	Global	Adds a TACACS+ server with its information. A.B.C.D: IP address KEY: authentication key value
no login tacacs server [*A.B.C.D*]		Deletes an added TACACS+ server.

i You can add up to 5 TACACS+ servers.

4.2.5.2 TACACS+ Server Priority

To specify the priority of a registered TACACS+ server, use the following command.

Command	Mode	Description
login tacacs server move *A.B.C.D* <1-5>	Global	Specifies the priority of TACACS+ server. A.B.C.D: IP address 1-5: priority of TACACS server

4.2.5.3 Timeout of Authentication Request

After the authentication request, the switch waits for the response from the TACACS+ server for specified time. To specify a timeout value, use the following command.

Command	Mode	Description
login tacacs timeout <1-100>	Global	Specifies a timeout value. 1-100: timeout value for the response (default: 5)
no login tacacs timeout		Deletes a specified timeout value.

4.2.5.4 Additional TACACS+ Configuration

The switch provides several additional options to configure the system authentication via TACACS+ server.

TCP Port for the Authentication

To specify TCP port for the system authentication, use the following command.

Command	Mode	Description
login tacacs socket-port <1-65535>	Global	Specifies TCP port for the authentication. 1-65535: TCP port
no login tacacs socket-port		Deleted the configured TCP port for the authentication

Authentication Type

To select the authentication type for TACACS+, use the following command.

Command	Mode	Description
login tacacs auth-type {**ascii** | **pap** | **chap**}	Global	Selects an authentication type for TACACS+. ascii: plain text pap: password authentication protocol chap: challenge handshake authentication protocol
no login tacacs auth-type		Deletes a specified authentication type.

Priority Level

According to a defined priority level, the user has different authority to access the system. This priority should be defined in the TACACS+ server in the same way. To define the priority level of user, use the following command.

Command	Mode	Description
login tacacs priority-level {**min** | **user** | **max** | **root**}	Global	Defines the priority level of user, see the below information for the order of priority.
no login tacacs priority-level		Deletes a defined priority level.

i The order of priority is **root** = **max** > **user** > **min**.

4.2.6 Accounting Mode

The switch provides the accounting function of AAA (Authentication, Authorization, and Accounting). Accounting is the process of measuring the resources a user has consumed. Typically, accounting measures the amount of system time a user has used or the amount of data a user has sent and received.

To set an accounting mode, use the following command.

Command	Mode	Description
login accounting-mode {**none** | **start** | **stop** | **both**}	Global	Sets an accounting mode. start: measures start point only. stop: measures stop point only. both: measures start and stop point both.
no login accounting-mode		Deletes a configured accounting mode.

4.2.7 Displaying System Authentication

To display a configured system authentication, use the following command.

Command	Mode	Description
show login	Enable Global Bridge	Shows a configured system authentication.

4.3 Configuring Interface

The Layer 2 switches only see the MAC address in an incoming packet to determine where the packet needs to come from/to and which ports should receive the packet. The Layer 2 switches do not need IP addresses to transmit packets. However, if you want to access to the switch from a remote place with TCP/IP through SNMP or telnet, it requires an IP address.

You can enable the interface to communicate with another network device on the network by assigning an IP address as follows:

- Enabling Interface
- Assigning IP Address to Network Interface
- Static Route and Default Gateway
- Interface Description
- Displaying Interface

4.3.1 Enabling Interface

To assign an IP address to an interface, you need to enable the interface first. If the interface is not enabled, you cannot access it from a remote place, even though an IP address has been assigned.

To configure an interface, you need to open *Interface Configuration* mode first. To open *Interface Configuration* mode, use the following command.

Command	Mode	Description
interface *INTERFACE*	Global Interface	Opens *Interface Configuration* mode to configure a specified interface.

To enable/disable an interface, use the following command.

Command	Mode	Description
no shutdown	Interface	Enables an interface.
shutdown		Disables an interface.

To enable/disable an interface in *Global Configaration* mode, use the following command.

Command	Mode	Description
interface noshutdown *INTERFACE*	Global	Enables an interface.
interface shutdown *INTERFACE*		Disables an interface.

The following is an example of enabling the interface 1.

```
SWITCH# configure terminal
SWITCH(config)# interface 1
SWITCH(config-if)# no shutdown
SWITCH(config-if)#
```

To display if an interface is enabled, use the **show running-config** command.

4.3.2 Assigning IP Address to Network Interface

After enabling an interface, assign an IP address. To assign an IP address to a network interface, use the following command.

Command	Mode	Description
ip address *A.B.C.D/M*	Interface	Assigns an IP address to an interface.
ip address *A.B.C.D/M* **secondary**		Assigns a secondary IP address to an interface.
ip address dhcp		Assigns an IP address from a DHCP server.
no ip address *A.B.C.D/M*		Clears an IP address assigned to an interface.
no ip address *A.B.C.D/M* **secondary**		Clears a secondary IP address assigned to an interface.
no ip address dhcp		Stops assigning an IP address from a DHCP server.

The **ip address dhcp** command is for configuring an interface as a DHCP client. For the detail of configuring a DHCP client, see Section 8.6.9.

To display an assigned IP address, use the following command.

Command	Mode	Description
show ip	Interface	Shows an IP address assigned to an interface.

4.3.3 Static Route and Default Gateway

The static route is a predefined route to a specific network and/or device such as a host. Unlike a dynamic routing protocol, static routes are not automatically updated and must be manually reconfigured if the network topology changes. Static route includes destination address, neighbor address, and etc. To configure a static route, use the following command.

To configure a static route, use the following command.

Command	Mode	Description
ip route *A.B.C.D SUBNET-MASK* {*GATEWAY* | **null**} [<1-255>]	Global	Configures a static route. A.B.C.D: destination IP prefix A.B.C.D/M: destination IP prefix with mask GATEWAY: gateway address 1-255: distance value src: binding source IP address
ip route *A.B.C.D/M* {*GATEWAY* | **null**} [<1-255> | **src** *A.B.C.D*]		

To delete a configured static route, use the following command.

Command	Mode	Description
no ip route *A.B.C.D SUBNET-MASK* {*GATEWAY* | **null**} [<1-255>]	Global	Deletes a configured static route.
no ip route *A.B.C.D/M* {*GATEWAY* | **null**} [<1-255>]		

To configure a default gateway, use the following command.

Command	Mode	Description
ip route default {*GATEWAY* | **null**} [<1-255>]	Global	Configures a default gateway.

To delete a configure default gateway, use the following command.

Command	Mode	Description
no ip route default {*GATEWAY* | **null**} [<1-255>]	Global	Deletes a default gateway.

To display a configured static route, use the following command.

Command	Mode	Description
show ip route [*A.B.C.D* | *A.B.C.D/M*]	Enable Global Bridge	Shows configured routing information.
show ip route database		Shows configured routing information with IP routing table database.

4.3.4 Interface Description

To specify a description on an interface, use the following command.

Command	Mode	Description
description *DESCRIPTION*	Interface	Specifies a description on an interface.
no description		Deletes a specified description.

The following is the example of specifying a description on the interface **1**.

```
SWITCH(config)# interface 1
SWITCH(config-if)# description sample_description
SWITCH(config-if)# show interface 1
Interface default
  Hardware is Ethernet, address is 00d0.cb00.0d83
  Description: sample_description
  index 43 metric 1 mtu 1500  <UP,BROADCAST,RUNNING,MULTICAST>
  VRF Binding: Not bound
  Bandwidth 100m
```

```
  inet 10.27.41.91/24 broadcast 10.27.41.255
    input packets 3208070, bytes 198412141, dropped 203750, multicast packets 0
    input errors 12, length 0, overrun 0, CRC 0, frame 0, fifo 12, missed 0
    output packets 11444, bytes 4192789, dropped 0
    output errors 0, aborted 0, carrier 0, fifo 0, heartbeat 0, window 0
    collisions 0
SWITCH(config)#
```

4.3.5 Displaying Interface

To display an interface status and configuration, use the following command.

Command	Mode	Description
show interface [*INTERFACE*]	Enable Global Bridge Interface	Shows an interface status and configuration. INTERFACE: interface name
show ip interface {*INTERFACE* | **brief**}	Enable Global Bridge	Shows brief information of interface. INTERFACE: interface name

The following is the sample output of the **show ip interface brief** command.

```
SWITCH(config)# show ip interface brief
Interface             IP-Address      Status              Protocol
lo                    unassigned      up                  up
mgmt                  10.27.41.91     up                  up
default               unassigned      up                  up
SWITCH(config)#
```

4.4 Secure Shell (SSH)

Network security is getting more important because the access network has been generalized among numerous users. However, typical FTP and telnet service have big weakness for their security. Secure shell (SSH) is a network protocol that allows establishing a secure channel between a local and a remote computer. It uses public-key cryptography to authenticate the remote computer and to allow the remote computer to authenticate the user.

4.4.1 SSH Server

The switch can be operated as SSH server. You can configure the switch as SSH server with the following procedure.

- Enabling SSH Server
- Displaying On-line SSH Client
- Disconnecting SSH Client
- Assigning Specific Authentication Key
- Displaying Connection History of SSH Client

4.4.1.1 Enabling SSH Server

To enable/disable SSH server, use the following command.

Command	Mode	Description
ssh server enable	Global	Enables SSH server.
ssh server disable		Disables SSH server.

4.4.1.2 Displaying On-line SSH Client

To display SSH clients connected to SSH server, use the following command.

Command	Mode	Description
show ssh	Enable Global Bridge	Shows SSH clients connected to SSH server.

4.4.1.3 Disconnecting SSH Client

To disconnect an SSH client connected to SSH server, use the following command.

Command	Mode	Description
ssh disconnect *PID*	Global	Disconnects SSH clients connected to SSH server. PID: SSH client number

4.4.1.4 Assigning Specific Authentication Key

After enabling SSH server, each client will upload its own generated authentication key. The SSH server can assign the specific key among the uploaded keys from several clients.

To verify an authentication key, use the following command.

Command	Mode	Description
ssh key verify *FILENAME*	Global	Verifies a generated authentication key.

i If the SSH server verify the key for specific client, other clients must download the key file from SSH server to login.

4.4.1.5 Displaying Connection History of SSH Client

To display the connection history of SSH client, use the following command.

Command	Mode	Description
show ssh history	Enable Global Bridge	Shows the connection history of SSH clients who are connected to SSH server up to now.

4.4.2 SSH Client

The switch can be used as SSH client with the following procedure.

- Login to SSH Server
- File Copy
- Authentication Key

4.4.2.1 Login to SSH Server

To login to SSH server after configuring the switch as SSH client, use the following command.

Command	Mode	Description
ssh login *DESTINATION* [*PUBLIC-KEY*]	Enable	Logins to SSH server. DESTINATION: IP address of SSH server PUBLIC-KEY: public key

4.4.2.2 File Copy

To copy a system configuration file from/to SSH server, use the following command.

Command	Mode	Description
copy {**scp** | **sftp**} **config** {**download** | **upload**} *FILENAME*	Enable	Downloads and uploads a file to through SSH server. FILE: destination file name

4.4.2.3 Authentication Key

SSH client can access to server through authentication key after configuring authentication key and informing it to server. It is safer to use authentication key than inputting password every time for login, and it is also possible to connect to several SSH servers with using one authentication key.

To configure an authentication key in the switch, use the following command.

Command	Mode	Description
ssh keygen {**rsa1** | **rsa** | **dsa**}	Global	Configures an authentication key. rsa1: SSH ver. 1 authentication rsa: SSH ver. 2 authentication dsa: SSH ver. 2 authentication FILENAME: key file name
copy {**scp** | **sftp**} **key upload** *FILENAME*	Enable	

To configure authentication key and connect to SSH server with the authentication key, perform the following procedure.

Step 1
Configure the authentication key in the switch.

```
SWITCH_A(config)# ssh keygen dsa
Generating public/private dsa key pair.
Enter file in which to save the key (/etc/.ssh/id_dsa):
Enter passphrase (empty for no passphrase):networks
Enter same passphrase again:networks
Your identification has been saved in /etc/.ssh/id_dsa.
Your public key has been saved in /etc/.ssh/id_dsa.pub.
The key fingerprint is:
d9:26:8e:3d:fa:06:31:95:f8:fe:f6:59:24:42:47:7e root@switch
SWITCH_A(config)#
```

Step 2
Copy the generated authentication key to SSH server.

Step 3
Connect to SSH server with the authentication key.

```
SWITCH_A(config)# ssh login 172.16.209.10
Enter passphrase for key '/etc/.ssh/id_dsa': networks
SWITCH_B#
```

4.5 802.1x Authentication

To enhance security and portability of network management, there are two ways of authentication based on MAC address and port-based authentication which restrict clients attempting to access to port.

Port-based authentication (802.1x) is used to authenticate the port self to access without users' count to access the network.

802.1x authentication adopts EAP (Extensible Authentication Protocol) structure. In EAP system, there are EAP-MD5 (Message Digest 5), EAP-TLS (Transport Level Security), EAP-SRP (Secure Remote Password), EAP-TTLS (Tunneled TLS) and the switch supports EAP-MD5 and EAP-TLS. Accessing with user's ID and password, EAP-MD5 is 1-way Authentication based on the password. EAP-TLS accesses through the mutual authentication system of server authentication and personal authentication and it is possible to guarantee high security because of mutual authentication system.

At a request of user Authentication, from user's PC EAPOL-Start type of packets are transmitted to authenticator and authenticator again requests identification. After getting respond about identification, request to approve access to RADIUS server and be authenticated by checking access through user's information.

The following figure explains the process of 802.1x authentication.

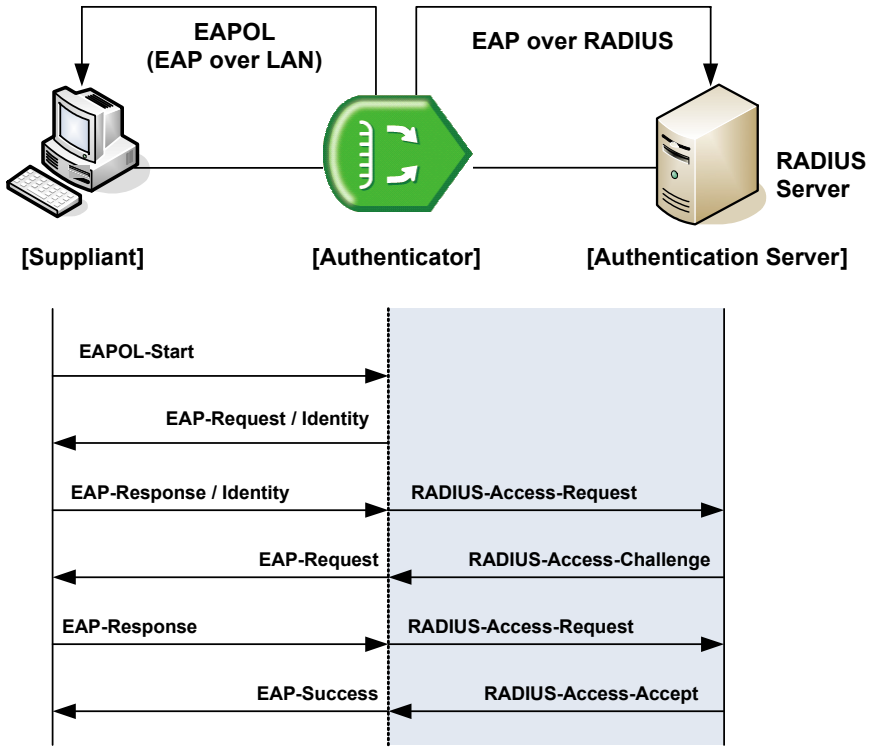


Fig. 4.1 Process of 802.1x Authentication

4.5.1 802.1x Authentication

4.5.1.1 Enabling 802.1x

To configure 802.1x, the user should enable 802.1x daemon first. To enable 802.1x daemon, use the following command.

Command	Mode	Description
dot1x system-auth-control	Global	Enables 802.1x daemon.
no dot1x system-auth-control		Disables 802.1x daemon.

4.5.1.2 RADIUS Server

As RADIUS server is registered in authenticator, authenticator also can be registered in RADIUS server.

Here, authenticator and RADIUS server need extra data authenticating each other besides they register each other's IP address. The data is key and should be the same value for each other. For the key value, every kinds of character can be used except the space or special character.

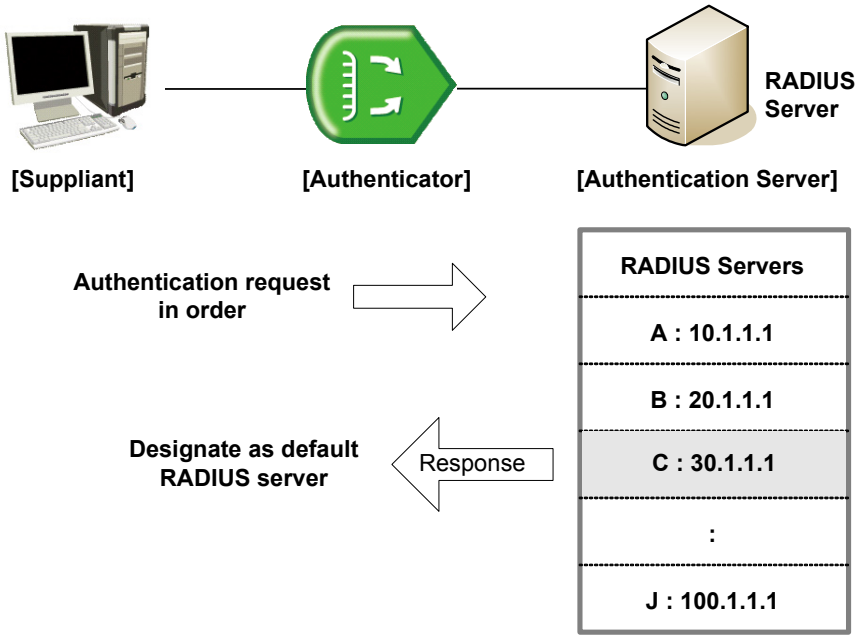


Fig. 4.2 Multiple Authentication Servers

If you register in several servers, the authentication server starts form RADIUS server registered as first one, then requests the second RADIUS server in case there's no response. According to the order of registering the authentication request, the authentication request is tried and the server which responds to it becomes the default server from the point of response time.

After default server is designated, all requests start from the RADIUS server. If there's no response from default server again, the authentication request is tried for RADIUS server designated as next one.

To configure IP address of RADIUS server and key value, use the following command.

Command	Mode	Description
dot1x radius-server host {*A.B.C.D* | *NAME*} **auth-port** <0-65535> **key** *KEY*	Global	Registers RADIUS server with key value and UDP port of radius server. 0-65535: UDP port (default: 1812)
dot1x radius-server host {*A.B.C.D* | *NAME*} **key** *KEY*		Configures IP address of RADIUS server and key value.
no dot1x radius-server host {*A.B.C.D* | *NAME*}		Deletes a registered RADIUS server.

You can designate up to 5 RADIUS servers as authentication server.

The **key** option is authentication information between the authenticator and RADIUS server. The authenticator and RADIUS server must have a same key value, and you can use alphabetic characters and numbers for the key value. The space or special character is not allowed.

To set priority to a registered RADIUS server, use the following command..

Command	Mode	Description
dot1x radius-server move {*A.B.C.D* | *NAME*} **priority** *PRIORITY*	Global	Sets priority to a registered RADIUS server.

4.5.1.3 Authentication Mode

You can set the authentication mode from the port-based to the MAC-based. To set the authentication mode, use the following command.

Command	Mode	Description
dot1x auth-mode mac-base *PORTS*	Global	Sets the authentication mode to the MAC-based.
no dot1x auth-mode mac-base *PORTS*		Restores the authentication mode to the port-based.

Before setting the authentication mode to the MAC-based, you need to set a MAC filtering policy to **deny** for all the Ethernet ports. To configure a MAC filtering policy, see Section 7.11.1.

4.5.1.4 Authentication Port

After configuring 802.1x authentication mode, you should select the authentication port.

Command	Mode	Description
dot1x nas-port *PORTS*	Global	Designates 802.1x authentication port.
no dot1x nas-port *PORTS*		Disables 802.1x authentication port.

4.5.1.5 Force Authorization

The switch can permit the users requesting the access regardless of the authentication from RADIUS server. For example, even though a client is authenticated from the server, it is possible to configure not to be authenticated from the server.

To manage the approval for the designated port, use the following command.

Command	Mode	Description
dot1x port-control {**auto** | **force-authorized** | **force-unauthorized**} *PORTS*	Global	Configures a state of the authentication port. auto: authorization up to RADIUS server (default) force-authorized: force authorization force-unauthorized: force unauthorization
no dot1x port-control *PORTS*		Deletes a configured authentication port state.

4.5.1.6 Interval for Retransmitting Request/Identity Packet

In the switch, it is possible to specify how long the device waits for a client to send back a response/identity packet after the device has sent a request/identity packet. If the client does not send back a response/identity packet during this time, the device retransmits the request/identity packet.

To configure the number of seconds that the switch waits for a response to a request/identity packet, use the following command.

Command	Mode	Description
dot1x timeout tx-period <1-65535> *PORTS*	Global	Sets reattempt interval for requesting request/identity packet. 1-65535: retransmit interval (default: 30)
no dot1x timeout tx-period *PORTS*		Disables the interval for requesting identity.

4.5.1.7 Number of Requests to RADIUS Server

After 802.1x authentication configured as explained above and the user tries to connect with the port, the process of authentication is progressed among user's PC and the equipment as authenticator and RADIUS server. It is possible to configure how many times the device which will be authenticator requests for authentication to RADIUS server.

To configure times of authentication request in the switch, please use the command in Global mode.

Command	Mode	Description
dot1x radius-server retries <1-10>	Global	Configure times of authentication request to RADIUS server. 1-10: retry number (default: 3)

4.5.1.8 Interval of Request to RADIUS Server

For the switch, it is possible to set the time for the retransmission of packets to check RADIUS server. If there's a response from other packets, the switch waits for a response from RADIUS server during the configured time before resending the request.

Command	Mode	Description
dot1x radius-server timeout <1-120>	Global	Configures the interval of request to RADIUS server. 1-120: interval (default: 1)

You should consider the distance from the server for configuring the interval of requesting the authentication to RADIUS server. If you configure the interval too short, the authentication couldn't be realized. If it happens, you'd better to reconfigure the interval longer.

4.5.2 802.1x Re-Authentication

In the switch, it is possible to update the authentication status on the port periodically. To enable re-authentication on the port, you should perform the below procedure.

Step 1
Enable 802.1x re-authentication.

Step 2
Configure the interval of re-authentication.

Step 3
Configure the interval of requesting re-authentication in case of re-authentication fails.

Step 4
Execute 802.1x re-authenticating regardless of the interval.

4.5.2.1 Enabling 802.1x Re-Authentication

To enable 802.1x re-authentication using the following command.

Command	Mode	Description
dot1x reauth-enable *PORTS*	Global	Enables 802.1x re-authentication.
no dot1x reauth-enable *PORTS*		Disables 802.1x re-authentication.

4.5.2.2 Interval of Re-Authentication

RAIDIUS server contains the database about the user who has access right. The database is real-time upgraded so it is possible for user to lose the access right by updated database even though he is once authenticated. In this case, even though the user is accessible to network, he should be authenticated once again so that the changed database is applied to. Besides, because of various reasons for managing RADIUS server and 802.1x authentication port, the user is supposed to be re-authenticated every regular time. The administrator of the switch can configure a term of re-authentication.

To configure a term of re-authentication, use the following command.

Command	Mode	Description
dot1x timeout reauth-period <1-4294967295> *PORTS*	Global	Sets the period between re-authentication attempts.
no dot1x timeout reauth-period *PORTS*		Deletes the period between re-authentication attempts.

4.5.2.3 Interval of Requesting Re-Authentication

When the authenticator sends request/identity packet for re-authentication and no response is received from the suppliant for the number of seconds, the authenticator retransmits the request to the suppliant. In the switch, you can set the number of seconds that the authenticator should wait for a response to request/identity packet from the suppliant before retransmitting the request.

To set reattempt interval for requesting request/identity packet, use the following command.

Command	Mode	Description
dot1x timeout quiet-period <1-65535> *PORTS*	Global	Sets reattempt interval for requesting request/identity packet. 1-65535: reattempt interval (default: 30)
no dot1x timeout quiet-period *PORTS*		Disables the interval for requesting identity.

4.5.2.4 802.1x Re-Authentication

In Section 4.5.2.2, it is described even though the user is accessible to network, he should be authenticated so that the changed database is applied to. Besides, because of various reasons managing RADIUS server and 802.1x authentication port, the user is supposed to be re-authenticated every regular time.

However, there are some cases of implementing re-authentication immediately. In the switch, it is possible to implement re-authentication immediately regardless of configured time interval.

Command	Mode	Description
dot1x reauthenticate *PORTS*	Global	Performs re-authentication regardless of the configured time interval.

4.5.3 Initializing Authentication Status

The user can initialize the entire configuration on the port. Once the port is initialized, the supplicants accessing to the port should be re-authenticated.

Command	Mode	Description
dot1x initialize *PORTS*	Global	Initializes the authentication status on the port.

4.5.4 Restoring Default Value

To restore the default value of the 802.1x configuration, use the following command.

Command	Mode	Description
dot1x default *PORTS*	Global	Restores the default value of the 802.1x configuration.

4.5.5 Displaying 802.1x Configuration

To display 802.1x configuration, use the following command.

Command	Mode	Description
show dot1x	Enable Global Bridge	Shows 802.1x configuration on the system.
show dot1x *PORTS*		Shows 802.1x configuration on the port.

4.5.6 802.1x User Authentication Statistics

It is possible for user to make reset state by showing and deleting the statistics of 802.1x user authentication.

To display the statistics about the process of 802.1x user authentication, use the following command.

Command	Mode	Description
show dot1x statistics *PORTS*	Enable Global Bridge	Shows the statistics of 802.1x user authentication on the port.

To make reset state by deleting the statistics of 802.1x user authentication, use the following command.

Command	Mode	Description
dot1x clear statistics *PORTS*	Global	Makes reset state by deleting the statistics of 802.1x on the port.

4.5.7 Sample Configuration

The following is the example of configuring the port 25 with the port-based authentication specifying the information of RADIUS server.

```
SWTICH(config)# dot1x system-auth-control
SWTICH(config)# dot1x nas-port 25
SWTICH(config)# dot1x port-control force-authorized 25
SWTICH(config)# dot1x radius-server host 10.1.1.1 auth-port 1812 key test
SWTICH(config)# show dot1x
802.1x authentication is enabled.
RADIUS Server TimeOut: 1(S)
RADIUS Server Retries: 3

RADIUS Server : 10.1.1.1 (Auth key : test)
-----------------------------------------------
          |         1         2         3
   802.1x  |12345678901234567890123456789012
-----------------------------------------------
 PortEnable |.....................p........
 PortAuthed |.....................u........
  MacEnable |................................
  MacAuthed |................................
-----------------------------------------------
p = port-based, m = mac-based, a = authenticated, u = unauthenticated
SWITCH(config)#
```

The following is the example of setting the interval of requesting reauthentication to 1000 sec and the interval of reauthentication to 1800 sec.

```
SWTICH(config)# dot1x timeout quiet-period 1000 25
SWTICH(config)# dot1x timeout reauth-period 1800 25
SWTICH(config)# dot1x reauth-enable 25
SWTICH(config)# show dot1x 25
Port 25
  SystemAuthControl  : Enabled
  ProtocolVersion    : 0
  PortControl        : Force-Authorized
  PortStatus         : Unauthorized
  ReauthEnabled      : True
  QuietPeriod        : 1000
  ReauthPeriod       : 1800
  TxPeriod           : 30
  PaeState           : INITIALIZE
SWITCH(config)#
```

The following is the example of configuring the port 25 with the MAC-based authentication.

```
SWTICH(config)# dot1x auth-mode mac-base 25
SWTICH(config)# show dot1x
802.1x authentication is enabled.
RADIUS Server TimeOut: 1(S)
RADIUS Server Retries: 3

RADIUS Server : 10.1.1.1 (Auth key : test)
-----------------------------------------------
           |          1         2         3
   802.1x  |12345678901234567890123456789012
-----------------------------------------------
 PortEnable |................................
 PortAuthed |................................
  MacEnable |.......................m........
  MacAuthed |.......................u........
-----------------------------------------------
p = port-based, m = mac-based, a = authenticated, u = unauthenticated
SWITCH(config)#
```

5 Port Configuration

The switch provides maximum 24 VDSL ports including integrated splitters. In this chapter, you can find the instructions for the basic port configuration such as auto-negotiation, flow control, transmit rate, etc. Please read the following instructions carefully before you configure a port in the switch.

This chapter contains the following sections.

- Port Basic
- Ethernet Port Configuration
- VDSL Port Configuration
- Port Mirroring

5.1 Port Basic

The switch provides 24 VDSL ports for the subscriber interface and 2 fixed ports of 10/100/1000Base-T Gigabit Ethernet and 1 optional module of 2 uplink ports(2-port SFP or 1-port GE-PON & 1-port SFP) supporting 100/1000Base-X interface.

5.2 Ethernet Port Configuration

5.2.1 Enabling Ethernet Port

To enable/disable the Ethernet port, use the following command.

Command	Mode	Description
port {**enable** | **disable**} *PORTS*	Bridge	Enables/disables a port, enter a port number. (default: enable)

The following is an example of disabling the Ethernet port 25.

```
SWITCH(bridge)# port disable 25
SWITCH(bridge)# show port 25
------------------------------------------------------------------------
NO      TYPE      PVID    STATUS       MODE       FLOWCTRL     INSTALLED
                        (ADMIN/OPER)
------------------------------------------------------------------------
25   Ethernet       2   Down/Down  Auto/Full/0       Off          Y
SWITCH(bridge)#
```

5.2.2 Auto-Negotiation

Auto-negotiation is a mechanism that takes control of the cable when a connection is established to a network device. Auto-negotiation detects the various modes that exist in the network device on the other end of the wire and advertises it own abilities to automatically configure the highest performance mode of interoperation. As a standard technology, this allows simple, automatic connection of devices that support a variety of modes from a va-

riety of manufacturers. To enable/disable the auto-negotiation on an Ethernet port, use the following command.

Command	Mode	Description
port nego *PORTS* {**on** | **off**}	Bridge	Enables/disables the auto-negotiation on a specified port, enter a port number. (default: on)

Auto-negotiation operates only on 10/100/1000Base-TX interface. You cannot enable this function on 1000Base-X optical interface.

The following is an example of disabling the auto-negotiation on the Ethernet port 25 and 26.

```
SWITCH(bridge)# show port 25-26
-------------------------------------------------------------------------
NO      TYPE      PVID    STATUS       MODE        FLOWCTRL     INSTALLED
                        (ADMIN/OPER)
-------------------------------------------------------------------------
25   Ethernet       1     Up/Up     Auto/Full/1000     Off         Y
26   Ethernet       1     Up/Up     Auto/Full/1000     Off         Y
SWITCH(bridge)# port nego 25-26 off
SWITCH(bridge)# show port 25-26
-------------------------------------------------------------------------
NO      TYPE      PVID    STATUS       MODE        FLOWCTRL     INSTALLED
                        (ADMIN/OPER)
-------------------------------------------------------------------------
25   Ethernet       1     Up/Up     Force/Full/1000    Off         Y
26   Ethernet       1     Up/Up     Force/Full/1000    Off         Y
SWITCH(bridge)#
```

5.2.3 Transmit Rate

To set the transmit rate of an Ethernet port, use the following command.

Command	Mode	Description
port speed *PORTS* {**10** | **100** | **1000**}	Bridge	Sets the transmit rate of a specified port to 10/100/1000Mbps, enter a port number.

Transmit rate is configurable only on 10/100/1000Base-TX interface. You cannot set transmit rate on 1000Base-X optical interface.

The following is an example of setting transmit rate on the Ethernet port 25 to 10 Mbps.

```
SWITCH(bridge)# show port 25
--------------------------------------------------------------------------
NO      TYPE      PVID    STATUS        MODE        FLOWCTRL     INSTALLED
                        (ADMIN/OPER)               (ADMIN/OPER)
--------------------------------------------------------------------------
25    Ethernet       2     Up/Up    Auto/Full/1000   Off/ Off       Y
SWITCH(bridge)# port speed 25 10
SWITCH(bridge)# show port 25
--------------------------------------------------------------------------
NO      TYPE      PVID    STATUS        MODE        FLOWCTRL     INSTALLED
                        (ADMIN/OPER)               (ADMIN/OPER)
--------------------------------------------------------------------------
25    Ethernet       2     Up/Up    Auto/Full/10    Off/ Off       Y
SWITCH(bridge)#
```

5.2.4 Duplex Mode

Ethernet operates in either half-duplex or full-duplex mode. In full-duplex mode, frames travel in both directions simultaneously over two channels on the same connection for an aggregate bandwidth of twice that of half-duplex mode. Full duplex networks are very efficient since data can be sent and received simultaneously.

To set the duplex mode on an Ethernet port, use the following command.

Command	Mode	Description
port duplex *PORTS* {**full** | **half**}	Bridge	Sets full-duplex or half-duplex mode on a specified port, enter a port number.

The following is an example of setting the duplex mode on the Ethernet port 25 to half-duplex mode.

```
SWITCH(bridge)# show port 25
--------------------------------------------------------------------------
NO      TYPE      PVID    STATUS        MODE        FLOWCTRL     INSTALLED
                        (ADMIN/OPER)               (ADMIN/OPER)
--------------------------------------------------------------------------
25    Ethernet       2     Up/Up    Auto/Full/1000   Off/ Off       Y
SWITCH(bridge)# port duplex 25 half
SWITCH(bridge)# show port 25
--------------------------------------------------------------------------
NO      TYPE      PVID    STATUS        MODE        FLOWCTRL     INSTALLED
                        (ADMIN/OPER)               (ADMIN/OPER)
--------------------------------------------------------------------------
25    Ethernet       2     Up/Up    Auto/Half/1000   Off/ Off       Y
SWITCH(bridge)#
```

5.2.5 Flow Control

In Ethernet networking, the flow control is the process of adjusting the flow of data from one network device to another to ensure that the receiving device can handle all of the incoming data. For this process, the receiving device normally sends a PAUSE frame to the sending device when its buffer is full. The sending device then stops sending data for a while. This is particularly important where the sending device is capable of sending data much faster than the receiving device can receive it.

To enable the flow control on an Ethernet port, use the following command.

Command	Mode	Description
port flow-control *PORTS* {**on** | **off**}	Bridge	Enables the flow control on a specified port, enter a port number. (default: off)

The following is an example of enabling the flow control on the Ethernet port 25.

```
SWITCH(bridge)# show port 25
-------------------------------------------------------------------------
NO      TYPE      PVID    STATUS        MODE        FLOWCTRL      INSTALLED
                        (ADMIN/OPER)               (ADMIN/OPER)
-------------------------------------------------------------------------
25   Ethernet       2     Up/Up    Auto/Full/1000   Off/ Off        Y
SWITCH(bridge)# port flow-control 25 on
SWITCH(bridge)# show port 25
-------------------------------------------------------------------------
NO      TYPE      PVID    STATUS        MODE        FLOWCTRL      INSTALLED
                        (ADMIN/OPER)               (ADMIN/OPER)
-------------------------------------------------------------------------
25   Ethernet       2     Up/Up    Auto/Full/1000   On/  On         Y
SWITCH(bridge)#
```

5.2.6 Port Description

To specify a description of an Ethernet port, use the following command.

Command	Mode	Description
port description *PORTS DESCRIPTION*	Bridge	Specifies a description of an Ethernet port. (maximum number of characters is 100)
no port description *PORTS*		Deletes a specified description of an Ethernet port.

5.2.7 Traffic Statistics

5.2.7.1 Packet Statistics

To display the traffic statistics of an Ethernet port, use the following command.

Command	Mode	Description
show port statistics avg-pkt [*PORTS*]	Enable Global Bridge	Shows the traffic statistics of the average packet for a specified Ethernet port.
show port statistics avg-pps [*PORTS*]		Shows the traffic statistics per packet type for a specified Ethernet port.
show port statistics interface [*PORTS*]		Shows the interface MIB counters of a specified Ethernet port.
show port statistics rmon [*PORTS*]		Shows the RMON MIB counters of a specified Ethernet port.
show port statistics media-adaptor [*PORTS*]		Shows the traffic statics per media adaptor unit of CO VDSL port.

The following is the sample output of the **show port statistics avg-pkt** command with the Ethernet port 25.

```
SWITCH(config)# show port statistics avg-pkt 25
================================================================================
Slot/Port|               Tx              |              Rx
--------------------------------------------------------------------------------
   Time   | pkts/s |  bytes/s |    bits/s    | pkts/s |  bytes/s |    bits/s
================================================================================
port 25  --------------------------------------------------------------------
  5 sec:          2        186        1,488       11       1106        8,848
  1 min:          0         60          480        3        148        1,872
 10 min:          0          6           48        1         15        1,184

SWITCH(config)#
```

To delete all collected statistics for an Ethernet port, use the following command.

Command	Mode	Description
clear port statistics {*PORTS* | **all**}	Enable Global Bridge	Deletes all collected statistics for an Ethernet port.

5.2.7.2 CPU Statistics

To display the statistics of the traffic handled by CPU, use the following command.

Command	Mode	Description
show cpu statistics avg-pkt [*PORTS*]	Enable Global Bridge	Shows the statistics of the traffic handled by CPU per packet type.
show cpu statistics total [*PORTS*]		Shows the traffic statistics of the average packet handled by CPU.

To delete the collected statistics of the traffic handled by CPU, use the following command.

Command	Mode	Description
clear cpu statistics [*PORTS*]	Global Bridge	Deletes the collected statistics of the traffic handled by CPU.

The following is the sample output of the **show cpu statistics total** command with the Ethernet port 25.

```
SWITCH(config)# show cpu statistics total 25
================================================================================
   Port  |                 Tx              |                Rx
--------------------------------------------------------------------------------
   Time  |   pkts   |   bytes   |    bits    |   pkts   |   bytes   |    bits
================================================================================
port 25 ------------------------------------------------------------------------
  Ucast:         43        3074        24592         0           0            0
  Mcast:     348025        2088     167052000         0           0            0
  Bcast:          0           0             0      1349       80940       647520

SWITCH(config)#
```

The switch can be configured to generate a syslog message when the number of the packets handled by CPU exceeds a specified value. This function allows system administrators to monitor the switch and network status more effectively.

To configure the switch to generate a syslog message according to the number of the packets handled by CPU, use the following command.

Command	Mode	Description
cpu statistics-limit {**unicast** | **multicast** | **broadcast**} *PORTS* <10-100>	Global	Generates a syslog message according to the specified number of the packets handled by CPU. This is configurable for each packet type and physical port. unicast | multicast | broadcast: packet type PORTS: port numbers 10-100: packet count (actual value: 1000-10000)

To disable the switch to generate a syslog message according to the number of the packets handled by CPU, use the following command.

Command	Mode	Description
no cpu statistics-limit {**unicast** | **multicast** | **broadcast**} {*PORTS* | **all**}	Enable Global	Disables the switch to generate a syslog message according to the number of the packets handled by CPU for each packet type. all: all physical ports
no cpu statistics-limit all {*PORTS* | **all**}		Disables the switch to generate a syslog message according to the number of the packets handled by CPU for all packet types.

To display a configured value to generate a syslog message according to the number of the packets handled by CPU, use the following command.

Command	Mode	Description
show cpu statistics-limit	Enable Global Bridge	Shows a configured value to generate a syslog message according to the number of the packets handled by CPU.

5.2.7.3 Protocol Statistics

To enables/disables the system to collect the statistics of the protocols, use the following command.

Command	Mode	Description
protocol statistics {**enable** | **disable**} [**arp** | **icmp** | **ip** | **tcp** | **udp**]	Global Bridge	Enables/disables the system to collect the statistics of the protocols. (ARP, ICMP, IP, TCP, UDP)

To display the statistics of the protocol, use the following command.

Command	Mode	Description
show protocol statistics avg-pkt [*PORTS*]	Enable Global Bridge	Shows the statistics of the protocol for average packets.
show protocol statistics total [*PORTS*]		Shows the traffic statistics of the protocol for total packets.

To delete the collected statistics of the protocol, use the following command.

Command	Mode	Description
clear protocol statistics [*PORTS*]	Global Bridge	Deletes the collected statistics of the protocol.

5.2.8 Port Information

To display the port information, use the following command.

Command	Mode	Description
show port [*PORTS*]	Enable Global Bridge	Shows a current port status, enter a port number.
show port description [*PORTS*]		Shows a specified port description, enter a port number.
show port module-info [*PORTS*]		Shows optical module (SFP) information.

The **show port module-info** command is only valid for Ethernet optical port. In case of using the command on the VDSL interface, the system shows the state as Uninstalled.

The following is an example of displaying the port information for port 20 to 26.

```
SWITCH(config)# show port 20-26

--------------------------------------------------------------------------
NO     TYPE     PVID    STATUS       MODE        FLOWCTRL     INSTALLED
                      (ADMIN/OPER)              (ADMIN/OPER)
--------------------------------------------------------------------------
20:      VDSL     1     Up/Down   Force/Full/100   On/  On       Y
21:      VDSL     1     Up/Down   Force/Full/100   On/  On       Y
22:      VDSL     1     Up/Down   Force/Full/100   On/  On       Y
23:      VDSL     1     Up/Down   Force/Full/100   On/  On       Y
24:      VDSL     1     Up/Down   Force/Full/100   On/  On       Y
25:   Ethernet    1     Up/Down    Auto/Half/0     Off/ Off      Y
26:   Ethernet    1     Up/Down    Auto/Half/0     Off/ Off      Y
SWITCH(config)#
```

5.3 VDSL Port Configuration

5.3.1 Modulation of VDSL Signal

The switch provides both Internet and telephone communication through existing telephone line with using DSL technology. DSL communication system requires technique to convert digital signal into analog signal and return the analog signal into the digital signal. Fig. 5.1 shows process of signal transmission in DSL system.

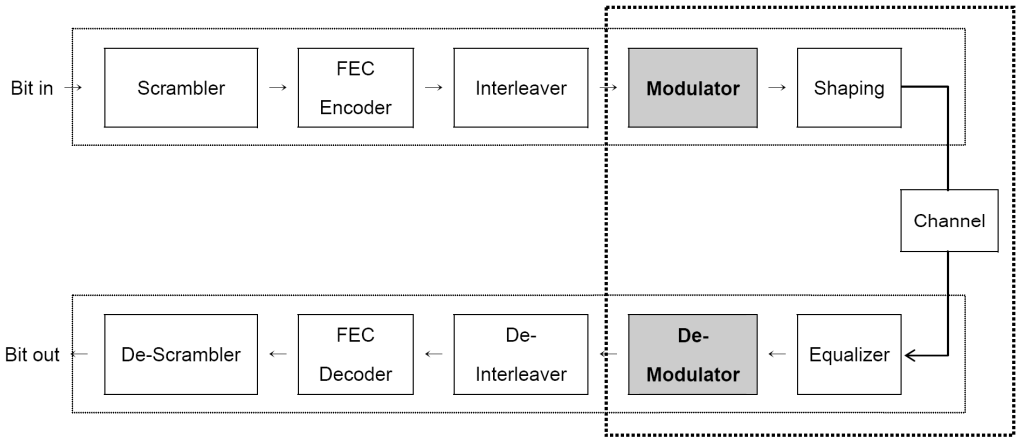


Fig. 5.1 Transmission in DSL System

In the above picture, Modulator converts digital signal into analog signal to be sent over the channel. Also, the analog signal is returned into digital signal at the Demodulator.

5.3.1.1 DMT Modulation

DMT builds on some of the ideas of QAM. Imagine having more than one constellation encoder. Each encoder receives a set of bits that are encoded using a constellation encoder as described in the previous sections. In this basis, DMT is referred as multi carrier

In DMT modulation, frequency channel is named frequency bins, bins, tone, DMT tones, and sub-channel.

Fig. 5.2 shows process of DMT modulation.

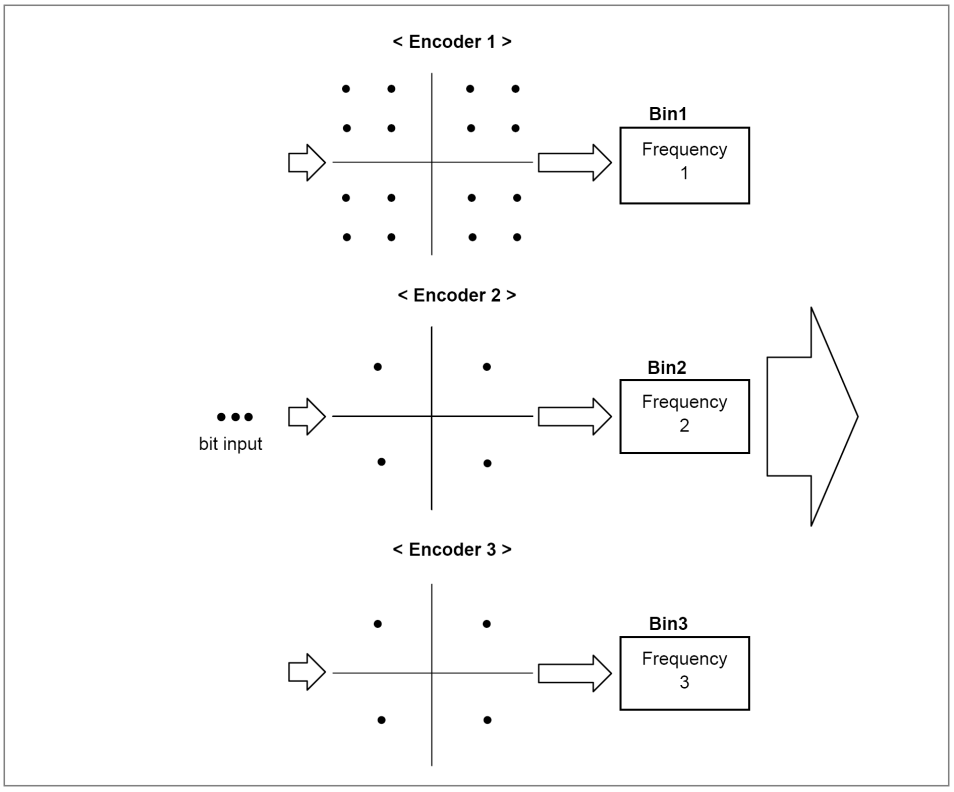


Fig. 5.2 DMT Modulation

Meanwhile, DMT using multi carrier can control carrier about exterior noise differently came from each frequency in detail, whereas chip implementation is more complicated than QAM and power consumption is quite high. Also, it is possible to process many digital signals. Although its fundamental is complicated, processing speed is faster than QAM.

5.3.2 Configuring VDSL Port

You can configure profile, interleave of VDSL port. This chapter describes the following lists.

- Displaying Status of VDSL Port
- Enabling VDSL Port
- Profile of VDSL Port
- Controlling Power according to Connection Distance
- PSD Level
- PSD Mask Level
- Interleave
- Impulse Noise Protection
- Trellis Coded Modulation (TCM)
- Ham-band
- SNR Margin
- Bitloading Per Tone
- G.handshake Tone

5.3.2.1 Displaying Status of VDSL Port

You can check status of VDSL port and user's configuration. It is also possible to view information of VDSL port. To check status of VDSL port and information of DMT modulation, use the following command

Command	Mode	Description
show lre [*PORTS*]	Enable Global Bridge	Shows VDSL port.
show lre detail-info [*PORTS*]		Shows detailed information of VDSL line.
show lre user-mac [*PORT*]		Shows MAC address of user connected to VDSL ports.
show lre profile [*PORTS*]		Shows the VDSL profile
show rate-info[*PORTS*]		Shows the rate information of VDSL line.
show lre psd [*PORTS*]		Shows PSD-mask-level

The above commands shows the following information. Therefore, you can choose command according to information you need.

Command	Description
bitload	Shows Bitloading Per Tone
ewl	Shows Electronic Wire Length
ham-band	Shows HAM Band
inp	Shows Upstream / Downstream Protection
interleave	Shows interleave-delay
pbo-config	Shows Power Back-Off Length configuration
profile	Shows Profile
psd	Shows PSD
rate-info	Shows rate information
snr	Shows SNR Margin

Tab. 5.1 Information displayed by Command, show lre

5.3.2.2 Enabling VDSL Port

This configuration of enabling VDSL port has different way of using with the configuration described in "Ethernet Port Configuration" Enabling VDSL port is to configure Sync status of partner's equipment. Therefore, although you connect to cable with VDSL port down, Sync is not configured. To configure Sync status of VDSL port, use the following command.

Command	Mode	Description
lre *PORTS* **up**	Bridge	Configures Sync with partner's equipment or resets VDSL port.
lre *PORTS* **down**		Disables Sync with partner's equipment.

Sync with the connected equipment is basically configured for VDSL port.

i This command is used not only to enable VDSL port but also to reset it when is on unstable status.

5.3.2.3 Profile of VDSL Port

It is possible to configure bandwidth of up/down stream of VDSL port. To configure the profile, use the following command.

Command	Mode	Description
lre *PORTS* **profile vdsl1** {**asym100_998** | **sym100_100_998**} {**normal** | **isdn** | **adsl** | **adsl-safe** | **tlan**}	Bridge	Configures profile of VDSL port.
lre *PORTS* **profile vdsl1** {**asym50_998** | **asym50_998_4b** | **sym25_997**} {**isdn** | **adsl** | **adsl-safe** | **tlan**}		
lre *PORTS* **profile vdsl1** {**asym50_998** | **asym50_998_4b** | **sym25_997**} **normal** {**annex-m** | **annex-a** | **annex-b** | **exclude**}		
lre *PORTS* **profile vdsl2** {**12b** |**12b_997**} {**normal** | **isdn** | **adsl** | **adsl2**}		
lre *PORTS* **profile vdsl2** {**12a** | **12a_997** | **17a** | **17a_8k** | **30a** | **8a** | **8b** | **8c** | **8d**} {**normal** | **isdn** | **adsl** | **adsl2**} {**annex-m** | **annex-a** | **annex-b** | **exclude**}		

Each profile provides the following bandwidth.

	Profile	Type
VDSL 1	asym100_998	PLAN 998 Asymmetric for 6Band DMT 50/100M (not support option band)
	asym50_998	PLAN 998 Asymmetric for DMT 50M
	asym50_998_4b	PLAN 998 Asymmetric for 4Band DMT 50M 8k tone
	sym100_100_998	PLAN 998 Symmetric for 6Band DMT 100/100M (not support option band)
	sym25_997	PLAN 997 Symmetric for DMT 50M
VDSL 2	12a	PLAN 998 Asymmetric for 4Band 12a
	12a_997	PLAN 997 Asymmetric for 5Band 12a
	17a	PLAN 998 Asymmetric for 5Band 17a
	17a_8k	PLAN 998 Asymmetric for 5Band 17a (tone space: 8k)
	30a	PLAN 998 Asymmetric for 6Band 30a
	12b	PLAN 998 Asymmetric for 4Band 12b (not support option band)
	12b_997	PLAN 997 Asymmetric for 4Band 12b (not support option band)
	8a	PLAN 998 Asymmetric for 3Band 8a
	8b	PLAN 998 Asymmetric for 3Band 8b (not support option band)
	8c	PLAN 998 Asymmetric for 3Band 8c
	8d	PLAN 998 Asymmetric for 3Band 8d

Tab. 5.2 Profile of VDSL Port

The default pofile of VDSL port is「30a」

Configuration for Profile of VDSL port is applied to all the ports.

The following table shows the option band types of VDSL port.

	Profile Mode	Description
Mode	adsl	ADSL friendly mode
	adsl2	ADSL2 + friendly mode
	adsl-safe	ADSL Safe mode
	isdn	ISDN friendly mode
	normal	Normal mode
	tlan	T-LAN friendly mode
Option Band	annex-a	Uses 6 to 32 tone in annex A environment in the direction of upstream
	annex-b	Uses 32 to 64 tone in annex B environment in the direction of upstream
	annex-m	Uses 6 to 64 tone in annex M environment in the direction of upstream
	exclude	Excludes option band

Tab. 5.3 Option band of VDSL Port

To display the configured lre profile, use the following command.

Command	Mode	Description
show lre profile	Enable/Global/Bridge	Displays the configured lre profile

The following is an example of displaying the configured lre profile

```
SWITCH(bridge)# show lre profile 1-8
--------------------------------------------------------------------------
Port  Status   Standard     Profile      Tone disable    Option
      ADM/OPR                               mode         Band
--------------------------------------------------------------------------
  1    Up/Down  VDSL2        17A          NORMAL         ANNEX_A
  2    Up/Down  VDSL2        17A          NORMAL         ANNEX_A
  3    Up/Down  VDSL2        17A          NORMAL         ANNEX_A
  4    Up/Down  VDSL2        17A          NORMAL         ANNEX_A
  5    Up/Down  VDSL2        17A          NORMAL         ANNEX_A
```

5.3.2.4 Controlling Power according to Connection Distance

The distance of connection from switch to VDSL line may vary according to each VDSL port. If same power is supplied to different connection distance, the power is larger than power supplied to line connected to CPE far from switch. It may cause interruption in the line connected to CPE far from the switch. You can control supplied power according to distance to prevent too large power supplied to VDSL line.

To control supplied power according to VDSL line, use the following command.

Command	Mode	Description
lre *PORTS* **upbo enable**	Bridge	Controls supplied power according to distance of VDSL line.

i You should control supplied power of VDSL port according to distance of VDSL line.

To disable power control according to distance of VDSL line, use the following command.

Command	Mode	Description
lre *PORTS* **upbo disable**	Bridge	Disables power control according to distance of VDSL line.

The following is an example of disabling power control according to distance of VDSL line.

```
SWITCH(bridge)# lre 1-3 upbo disable
SWITCH(bridge)# show lre psd 1-5
------------------------------------------------------------
Port  Status     Up Stream      PBO Length       PSD MASK
      ADM/OPR      PBO         (10  Custom)       Level
                            ---------------------
                           | u0 | u1 | u2 | u3 |
------------------------------------------------------------
1     Up/Up     disable    |  2 |  2 |  2 |  2 |      11
2     Up/Up     disable    |  2 |  2 |  2 |  2 |      11
3     Up/Down   disable    |  2 |  2 |  2 |  2 |      11
4     Up/Down   Enable     |  2 |  2 |  2 |  2 |      11
5     Up/Down   Enable     |  2 |  2 |  2 |  2 |      11
SWITCH(bridge)#
```

! If you control power according to VDSL line, it is applied to all ports.

You cannot configure power consumption supplied to VDSL line with power control according to the distance of line enabled. In this case, the standard to decide power consumption is the distance.

To configure power consumption supplied to VDSL line, use the following command.

Command	Mode	Description
lre *PORTS* **pbo-length** {1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10}	Bridge	Configures power consumption supplied to VDSL line according to the distance.

i The default is “2”.

To configure the power back-off length of each upstream band, use the following command.

Command	Mode	Description
lre *PORTS* **band-pbo-length u0** *LENGTH* [**u1** *LENGTH*]	Bridge	Configures the power back-off length per upstream band. LENGTH: distance from 100m to 900m (1-10) u1-u4: U1-U4 band configuration
lre *PORTS* **band-pbo-length u0** *LENGTH* **u1** *LENGTH* [**u2** *LENGTH*]		
lre *PORTS* **band-pbo-length u0** *LENGTH* **u1** *LENGTH* **u2** *LENGTH* [**u3** *LENGTH*]		

The following table shows distance of 1 ~ 9 in the above command. Each variable means as the below.

No	Distance (Unit : m)	No	Distance (Unit : m)
1	100	**6**	600
2	200	**7**	700
3	300	**8**	800
4	400	**9**	900
5	500	**10**	User Definition

Tab. 5.4 Value of PBO-Length

You should control supplied power of VDSL port according to distance of VDSL line.

The following is an example of configuring power consumption as 400m.

```
SWITCH(bridge)# lre 1-5 pbo-length 4
SWITCH(bridge)# show lre psd 1-7
------------------------------------------------------------
Port  Status     Up Stream      PBO Length       PSD MASK
      ADM/OPR      PBO         (10  Custom)       Level
                          ---------------------
                          | u0 | u1 | u2 | u3 |
------------------------------------------------------------
1      Up/Down   Enable      |  4 |  4 |  4 |  4 |      1
2      Up/Down   Enable      |  4 |  4 |  4 |  4 |      1
3      Up/Down   Enable      |  4 |  4 |  4 |  4 |      1
4      Up/Down   Enable      |  4 |  4 |  4 |  4 |      1
5      Up/Down   Enable      |  4 |  4 |  4 |  4 |      1
6      Up/Down   Enable      |  2 |  2 |  2 |  2 |      1
7      Up/Down   Enable      |  2 |  2 |  2 |  2 |      1

SWITCH(bridge)#
```

The following is an example of configuring the power consumption per upstream band of port 1 as 100m to 400m.

```
SWITCH(bridge)# lre 1 band-pbo-length u0 1 u1 2 u2 3 u3 4
SWITCH(bridge)# show lre psd 1-7
-------------------------------------------------------------
Port  Status    Up Stream      PBO Length       PSD MASK
     ADM/OPR     PBO         (10  Custom)       Level
                          --------------------
                         | u0 | u1 | u2 | u3 |
-------------------------------------------------------------
1     Up/Down   Enable      | 1 | 2 | 3 | 4 |      1
2     Up/Down   Enable      | 4 | 4 | 4 | 4 |      1
3     Up/Down   Enable      | 4 | 4 | 4 | 4 |      1
4     Up/Down   Enable      | 4 | 4 | 4 | 4 |      1
5     Up/Down   Enable      | 4 | 4 | 4 | 4 |      1
6     Up/Down   Enable      | 2 | 2 | 2 | 2 |      1
7     Up/Down   Enable      | 2 | 2 | 2 | 2 |      1

SWITCH(bridge)#
```

However, even though inner value of PBO-Length is already configured and user configured the most appropriate PBO-Length, inner value could be unfit according to detailed environment To improve this point, in switch it is possible that user configure the attribute of PBO-Length. The attribute of PBO-Length is appointed as PBO-Config, user's default PBO-Config is appointed as PBO-Length "10".

To configure PBO-config, use the following command.

Command	Mode	Description
lre pbo-config *K1[1] K1[2] K1[3] K2[1] K2[2] K2[3]*	Bridge	Sets the attribute of PBO-Length.

The first value of Upstream in k1 and k2 comes under option band, the second value comes under Upstream used for 3Band, and the third value comes under the second Upstream used for 4band.

To display PBO-Config, use the following command.

Command	Mode	Description
show lre pbo-config	Enable Global Bridge	Shows the attribute of PBO-Length.

5.3.2.5 PSD Level

Power Spectral Density (PSD) Level is configured according to the standard but PSD-Level can be configured as the frequency by the administrator. To configure PSD-Level, use the following command.

Command	Mode	Description
lre *PORTS* **psd-level** { 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15} {*PSD* | **default** | **off**}	Bridge	Configures PSD value and frequency vlaue in VDSL line. PSD: -80dBm ~ -40dBm

Band	Frequency (kHz)		Band	Frequency (kHz)	
0	27 ~ 138	up/down	**8**	4,508 ~ 5,200	up/down
1	143 ~ 256	down	**9**	5,208 ~ 7,000	up/down
2	261 ~ 640	down	**10**	7,008 ~ 8,500	up/down
3	648 ~ 1,100	down	**11**	8,508 ~ 12,000	up/down
4	1,108 ~ 2,000	down	**12**	12,008 ~ 16,700	up/down
5	2,008 ~ 3,000	down	**13**	16,708 ~ 17,600	up/down
6	3,008 ~ 3,750	down	**14**	17,608 ~ 18,100	up/down
7	3,758 ~ 4,500	up/down	**15**	18,108 ~ 30,000	up/down

Tab. 5.5 The frequency of PSD Level per band

To display PSD level, use the following command.

Command	Mode	Description
show lre psd-level [*PORTS*]	Enable Global Bridge	Shows PSD level in VDSL line.

The following is an example of configuring PSD levle.

```
SWITCH(bridge)# lre 1 psd-level 10 -60
SWITCH(bridge)# show lre psd-level 1
-------------------------------------
 PORT 1
 BAND Frequency (kHz)     PSD (dBm)
-------------------------------------
  0     27 -   138       default
  1    143 -   256       default
  2    261 -   640       default
  3    648 -  1100       default
  4   1108 -  2000       default
  5   2008 -  3000       default
  6   3008 -  3750       default
  7   3758 -  4500       default
  8   4508 -  5200       default
  9   5208 -  7000       default
 10   7008 -  8500       -60.0
```

```
 11    8508 - 12000       default
 12   12008 - 16700       default
 13   16708 - 17600       default
 14   17608 - 18100       default
 15   18108 - 30000       default
SWITCH(bridge)#
```

5.3.2.6 PSD Mask Level

To configure PSD-Level, use the following command.

Command	Mode	Description
lre *PORTS* **psd-mask-level** { 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 }	Bridge	Configures PSD Mask Level in VDSL line.

PSD Level is basically configured as Default.

Level	Value	Level	Value
0	old gains	**8**	ETSI M1_EX
1	ANSI M1_CAB	**9**	ETSI M2_EX
2	ANSI M2_CAB	**10**	Reserved
3	ETSI M1_CAB	**11**	PSD K
4	ETSI M2_CAB	**12**	PSD CHINA
5	ANNEX F	**13**	ETSI M1_EX P1
6	ANSI M1_EX	**14**	ETSI M2_EX P1
7	ANSI M2_EX		

Tab. 5.6 The Value of PSD Mask Level

If you configure PSD MASK Level of VDSL line, it is applied to all ports.

5.3.2.7 Interleave

There is Interleave process to correct data error before modulation digital signal into analog signal. Interleave gathers certain size of data, re-organize the gathered data, and transmit the data divided by certain size. In the below image, you can see disperse errors by re-organizing gathered data through Interleave.

By the way, Interleave prevents error by enhanced correction but may slow down transmit rate because packets are gathered. Therefore you need to consider user's condition to configure mode. On the other hand, if you skip Interleave process, error correction will not be done well, whereas transmit rate of data becomes faster. You can skip Interleave process and configure it before transmitting data.

To skip Interleave process, use the following command.

Command	Mode	Description
lre *PORTS* **channel fast**	Bridge	Skips Interleave process

To enable Interleave process, use the following command.

Command	Mode	Description
lre *PORTS* **channel slow**	Bridge	Enables Interleave process.

The default is Interleave enabled as “**slow**”.

The following is an example of displaying Interleave.

```
SWITCH(bridge)# show lre interleave  1-5
-----------------------------------------
Port  Status     Channel    Inter-Delay
      ADM/OPR               UP/DOWN
-----------------------------------------
  1    Up/Down     Slow       2/  2
  2    Up/Down     Slow       2/  2
  3    Up/Down     Slow       2/  2
  4    Up/Down     Slow       2/  2
  5    Up/Down     Slow       2/  2
SWITCH(bridge)#
```

In addition, you can configure the interval of Interleave process during modulation. This interval is called Interleave-delay. By configuring Interleave-delay, you can prevent transmission delay caused of waiting data gathered.

To configure Interleave-delay, use the following command.

Command	Mode	Description
lre *PORTS* **interleave-delay** <1-100>	Bridge	Configures Interleave-delay PORTS: VDSL port number 1-100: interleave delay value (default:2 ms)
lre *PORTS* **interleave-delay** <1-100> {**up** | **down**}		Configures Interleave-delay with specifying Upstream or Downstream.

The unit of Interleave-delay is “ms” and the default is “2ms”.

In switch, all VDSL ports are contained in one Line-config-profile. For the ports contained as the member port of Line-config-profile, it is not possible to change Interleave-delay or SNR margin.

To change it independently, erase the member of Line-config-profile first refer to 5.3.4.1 Line config profile. If you try to configure interleave-delay of the port which is contained as Line-config-profile member, the error message will be displayed.

To display configured interleave delay, use the following command

Command	Mode	Description
show lre interleave [*PORTS*]	Enable Global Bridge	Shows the configuration of interleave delay.

The following is an example of configuring Interleave-delay of port 50 as 50ms.

```
SWITCH(bridge)# lre 5 interleave-delay 50
SWITCH(bridge)# show lre interleave 1-5
-----------------------------------------
Port  Status     Channel    Inter-Delay
      ADM/OPR               UP/DOWN
-----------------------------------------
1       Up/Down     Slow       2/  2
2       Up/Down     Slow       2/  2
3       Up/Down     Slow       2/  2
4       Up/Down     Slow       2/  2
5       Up/Down     Slow      50/ 50
SWITCH(bridge)#
```

5.3.2.8 Impulse Noise Protection

Use the following command to configure minimum protection value of port provision.

Command	Mode	Description
lre *PORTS* **inp** <0-255>	Bridge	Configures INP 0-255: INP value (default:0)
lre *PORTS* **inp** <0-255> { **up** | **down** }		Configures INP with specifying Upstream or Downstream.

i The unit of value is 125 usec and configured “0” as default

To display a configured INP, use the following command

Command	Mode	Description
show lre inp [*PORTS*]	Enable Global Bridge	Shows the configured INP in VDSL line.

5.3.2.9 Trellis Coded Modulation (TCM)

The trellis coded modulation (TCM) is a modulation scheme which allows highly efficient transmission of information over band-limited channels such as telephone lines.

To enable/disable TCM of VDSL line port, use the following command. .

Command	Mode	Description
lre *PORTS* **tcm** {**enable	disable**}	Bridge	Configures TCM (default: enable)

To display configured TCM, use the following command.

Command	Mode	Description
show lre tcm [*PORTS*]	Enable/Global/Bridge	Shows the configured TCM.

5.3.2.10 Ham-band

The bandwidth that VDSL port of switch includes Ham band. It causes interruption in VDSL line. To prevent this interruption, you can configure not to use Ham band in bandwidth.

To disable specified Ham band for a port, use the following command.

Command	Mode	Description
lre *PORTS* **ham-band** {**band1** | **band2** | **band3** | **band4** | **band5** | **band6** | **band7** | **band8** | **band9** | **band10** | **band11** | **band12** | **band13** | **band14** | **band15** | **band16** | **band17** | **band18** | **band19** | **band20** | **band21**}	Bridge	Disables specified Ham band.

If you configure Ham band at VDSL port, it is applied to all ports.

To enable Ham band of a port, use the following command.

Command	Mode	Description
no lre *PORTS* **ham-band** {**all** | *BAND NO*}	Bridge	Enables disabled Ham-band.

To confirm disabled Ham band, use the following command

Command	Mode	Description
show lre ham-band [*PORTS*]	Enable/Global/Bridge	Shows disabled Ham-band.

You can configure plural Ham bands, up to thirteen bands. For example, if you input band1, band2, band3 in order, then three Ham bands.

The following table shows bandwidth of Ham band frequency.

Ham band	Bandwidth of Frequency(Unit:MHz)	Standard
band1	1.800 ~ 1.810	RFI Notch
band2	1.800 ~ 1.825	KOREA HAM-BAND
band3	1.810 ~ 1.825	ANNEX F
band4	1.810 ~ 2.000	ETSI, T1E1
band5	1.9075 ~ 1.9125	ANNEX F
band6	3.500 ~ 3.550	KOREA HAM-BAND
band7	3.500 ~ 3.575	ANNEX F
band8	3.500 ~ 3.800	ETSI
band9	3.500 ~ 4.000	T1E1
band10	3.747 ~ 3.754	ANNEX F
band11	3.790 ~ 3.800	KOREA HAM-BAND
band12	3.791 ~ 3.805	ANNEX F
band13	7.000 ~ 7.100	KOREA HAM-BAND ANNEX F, ETSI
band14	7.000 ~ 7.300	T1E1
band15	10.100 ~ 10.150	KOREA HAM-BAND, ANNEX F, ETSI, T1E1
band16	14.000 ~ 14.350	ANNEX F, ETSI, T1E1
band17	18.068 ~ 18.168	ANNEX F, ETSI, T1E1
band18	21.000 ~ 21.450	ANNEX F, ETSI, T1E1
band19	24.890 ~ 24.990	ANNEX F, ETSI, T1E1
band20	28.000 ~ 29.100	ETSI
band21	28.000 ~ 29.700	ANNEX F, ETSI, T1E1

Tab. 5.7 Bandwidth of Ham band Frequency

The following is an example of disabling Ham band 1 and Ham band 3 of VDSL port 1 and 2.

```
SWITCH(bridge)# lre 1-2 ham-band band1 band3
SWITCH(bridge)# show lre ham-band 1-4
--------------------------------------------------------------------------------
Port  Status                      HAM Band
     ADM/OPR   1| 2| 3| 4| 5| 6| 7| 8| 9|10|11|12|13|14|15|16|17|18|19|20|21
--------------------------------------------------------------------------------
  1    Up/Down  1|  | 3|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
  2    Up/Down  1|  | 3|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
  3    Up/Down   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
  4    Up/Down   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
SWITCH(bridge)#
```

5.3.2.11 SNR Margin

In digital and analog communication, SNR(Signal to Noise Ratio) ratio of signal divided by noise. When the signal strength is referred as Vs and the noise strength is referred as Vn, the formula can be 「SNR(dB) = 20 log10(Vs/Vn)」.When the signal strength is same

with or less than the noise strength, stable communication cannot be done. Therefore, SNT must not be minus or “0”. And, if there is this situation, you have to increase signal strength or decrease noise strength.

Transmit rate of VDSL line depends of SNR. But, environment of line cannot be always same. So you need to configure transmit rate of VDSL line can be decided according to changing line environment. If noise is suddenly increased, SNR is decreased and communication becomes unstable.

Therefore you should configure transmit rate for decreased SNR when noise is suddenly increased. Then there will not be problem with communication although noise is suddenly increased.

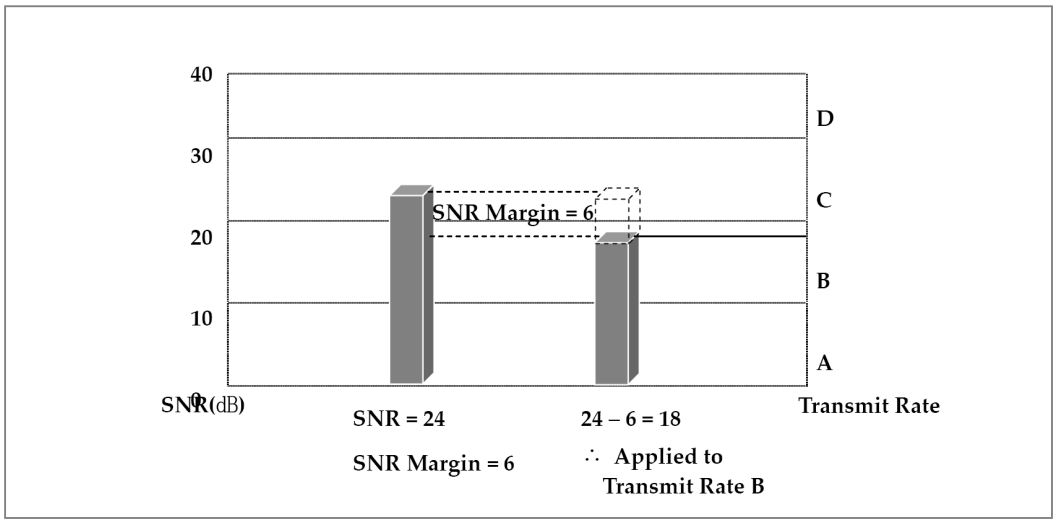


Fig. 5.3 Deciding Transmit Rate according to SNR Margin

When you configure estimate SNR, the difference between estimate SNR and current SNR is call「**SNR Margin**」. The switch applies the SNR margin to transmit rate In other word, if you configure SNR margin as “6”, the difference that subtracts 6 from current SNR will be applied to transmit rate as the above picture

In you think there will be big change of noise, configure big SNR margin. However, if you configure too big SNR margin, transmit rate will be slow down, whereas communication is stable.

To configure SNR margin, use the following command.

Command	Mode	Description
lre *PORTS* **snr-target-margin** <0-31> [**up** | **down**]	Bridge	Configures SNR margin of Downstream or Upstream. 0-31: SNR margin value (default:6 dB)
lre *PORTS* **snr-min-margin** <0-31> [**up** | **down**]		Configures minimum SNR margin 0-31: minimum SNR margin value (default: 5 dB)

To display SNR margin, use the following command.

Command	Mode	Description
show lre snr [*PORTS*]	Enable/Global/Bridge	Shows the configuration of SNR margin.

The following is an example of configuring SNR margin of port 3 as "10dB".

```
SWITCH(bridge)# lre 3 snr-target-margin 10 down
SWITCH(bridge)# show lre snr 1-5
-----------------------------------------------------
Port  Status    Config SNR Target   SNR Minimum
     ADM/OPR        Margin            Margin
                   UP/DOWN           UP/DOWN
-----------------------------------------------------
1     Up/Down       6/ 6             5/ 5
2     Up/Down       6/ 6             5/ 5
3     Up/Down       6/ 10            5/ 5
4     Up/Down       6/ 6             5/ 5
5     Up/Down       6/ 6             5/ 5
SWITCH(bridge)#
```

5.3.2.12 Bitloading Per Tone

The bitloading per tone command is used to fetch the table that shows bit loading, SNR, attenuation, FEQ fine coeff, noise margin, and so on.

To display the table of each parameter in the range of tone, use the following command.

Command	Mode	Description
show lre pertoneinfo *PORT* {**rx-bit-ne** | **tx-bit-ne** | **snr-ne** | **noise-margin-ne** | **atten-ne** | **feq-ne** | **tx-pwr-ne** | **tx-gi-ne** | **qln-ne** | **coarse-feq-ne** } <0-4095> <0-4095> [**graph** <1-4095>]	Enable Global Bridge	Shows the table of each parameter (bit-loading, SNR, FEQ fine coeff, noie-margin and so on) in the range of tone. 0-4095: start/ stop tone index

To display the table of each parameter in the range of tone, use the following command.

Command	Mode	Description
show lre pertoneinfo *PORT* { **block** | **hlog-ne** | **hlin-ne** | **hlin-scale-ne** <0-511> <0-511>	Enable Global Bridge	Shows the table of each parameter (bitloading, SNR, FEQ fine coeff, noie-margin and so on) in the range of tone. 0-511: start/ stop tone index

The following table lists the sub-commands in the Bitloading per tone command.

Sub-command	Description
tx-bit-ne	Get Tx Per Tone BitLoading Info Near End
snr-ne	Get Rx Per Tone SNR Info Near End
noise-margin-ne	Get Rx Per Tone Noise Margin Near End
feq-ne	Get Rx Per Tone Current FEQ ine Coeffs Near End
tx-pwr-ne	Get Tx Per Tone Tx Power Near End
tx-gi-ne	Get Tx Per Tone Gi Near End
qln-ne	Get Rx Per Tone Quiet Line Noise Near End
coarse-feq-ne	Rx Per Tone Coarse FEQ Near End
block	Get Param Block Read Far End (valid for ADSL2/2+/VDSL2 only)
hlog-ne	Get Per Tone HLOG Info Near End (valid for ADSL2/2+ only)
hlin-ne	Get Per Tone HLIN Info Near End
hlin-scale-ne	Get Per Tone HLIN Scale Near End

Tab. 5.8 Sub-commands in Bitloading Per Tone

5.3.2.13 G.handshake Tone

To configure G.handshake tone of each port, use the following command.

Command	Mode	Description
lre *PORTS* **ghs a43** [**i43**] [**v43**]	Bridge	Configures G.hs tone carrier of each port a43, b43, i43, v43: A43, B43, I43, V43 Carrier Set none: None G.hs Carrier mode
lre *PORTS* **ghs b43** [**i43]** [**v43**]		
lre *PORTS* **ghs none**		

i You can not configure A43 G.hs carrier with B43 at the same time.

To display the G.hs Carrier configuration of each port, use the following command.

Command	Mode	Description
show lre ghs [*PORTS*]	Enable Global Bridge	Shows G.hs carrier configuration of each port.

5.3.3 VDSL Checking Errors of VDSL Port

In switch it is possible to check times of error from VDSL port every time interval. Moreover, it is possible to check the error duration time.

Checking Times of Errors

You can check how many times CRC errors, Frame loss and Signal loss are happened. Error is counted every 15 minutes after booting. After the time is over, the number is reset to “0” and error is counted again. In addition, error is counted by each day. It is also reset to “0” after the day. Consequently, you can check times of error (Curr.15m) at present

time from beginning of the 15 minutes and time of error (Prev. 15m) of previous 15 minutes. Also, you can check times of error (Today) at present time from starting Today, times of error (Yesterday) of yesterday, and total times of error from booting. The following image shows standard of error counting provided in switch.

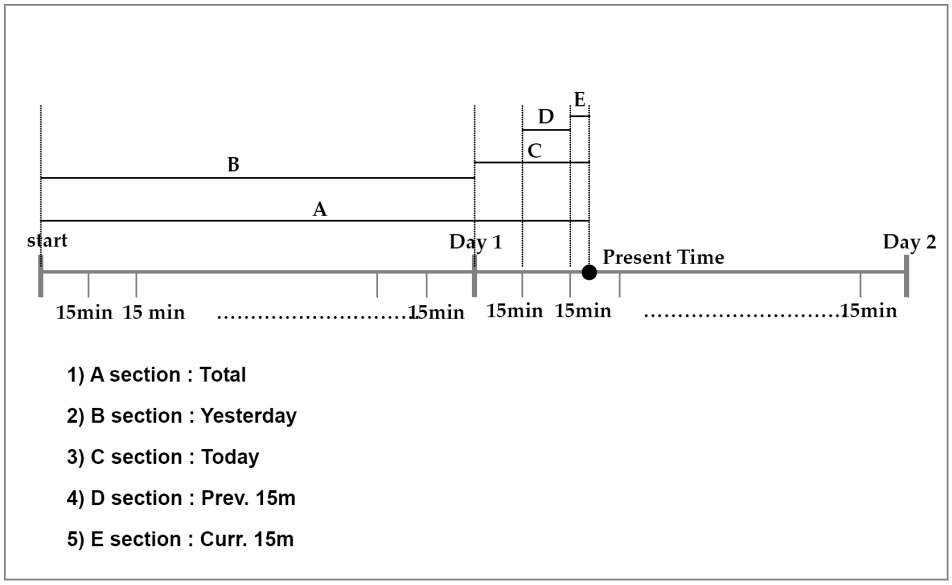


Fig. 5.4 Counting Times of Error

To display the number of errors in VDSL port, use the following command.

Command	Mode	Description
show lre stat-correctable-crc *PORTS*	Enable Global Bridge	Shows the numbers of CRC errors that can be correctable.
show lre stat-lof *PORTS*		Shows the numbers of Frame loss.
show lre stat-los *PORTS*		Shows the numbers of Signal loss.
show lre stat-lol *PORTS*		Shows the numbers of Link loss.
show lre stat-lpr *PORTS*		Shows the numbers of CPE's Power loss
show lre stat-crc *PORTS*		Shows the numbers of CRC errors
show lre stat-uncorrectable-crc *PORTS*		Shows the numbers of CRC errors that can be uncorrectable.

To reset data of CRC error, Frame loss and Signal loss, use the following command.

Command	Mode	Description
clear lre stat-correctable-crc *PORTS*	Enable Global Bridge	Resets data of error.
clear lre stat-lof *PORTS*		
clear lre stat-los *PORTS*		
clear lre stat-lol *PORTS*		
clear lre stat-lpr *PORTS*		
clear lre stat-crc *PORTS*		
clear lre stat-uncorrectable-crc *PORTS*		

To check CRC error, Frame losses, and Signal loss of specific port at a time, use the following command

Command	Mode	Description
show lre stat-count-all *PORTS*	Enable Global Bridge	Shows data of CRC error, Frame loss, and Signal loss at a time about Upstream
show cpe stat-count-all [*PORTS*]		Shows data of CRC error, Frame loss, and Signal loss at a time about Downstream
show lre total-error [*PORTS*]		Shows the collected data of all errors.
clear stat-error [*PORTS*]		Reset error information about Upstream
clear cpe stat-error [*PORTS*]		Reset error information about Downstream

The following is an example of checking all errors of port 1 to port 5 at a time.

```
SWITCH(bridge)# show lre stat-count-all 1-5

--------------------------------------------------------------------------------
 Port   Status       LOS       LOF       LOL     CorrBlk   UnCorrBlk    CRC
--------------------------------------------------------------------------------

1       Down         0         0         0         0         0         0
2       Down         0         0         0         0         0         0
3       Down         0         0         0         0         0         0
4       Down         0         0         0         0         0         0
5       Down         0         0         0         0         0         0
SWITCH(bridge)#
```

You can check how many times each port is disconnected and how long it is disconnected. As the same way with counting times of CRC error and Frame loss of VDSL port, it is counted every 15 minutes and each day.

To check how long have the errors in downstream of VDSL line been lasted, use the following command.

Command	Mode	Description
show lre stat-crc-sec [*PORTS*]	Enable Global Bridge	Shows how long CRC error has been happening.
show lre stat-es-sec [*PORTS*]		Shows how long CRC, LOF. and LOS. error has been happening.
show lre stat-lof-sec [*PORTS*]		Shows how long Frame loss has been happened.
show lre stat-lol-sec [*PORTS*]		Shows how long Link has been disconnected.
show lre stat-los-sec [*PORTS*]		Shows how long Signal loss has been happening.
show lre stat-lpr-sec [*PORTS*]		Shows how long RX power of port has being lower than specific voltage.
show lre stat-ses-sec [*PORTS*]		Shows how long server error has been happening.
show lre stat-uas-sec [*PORTS*]		Shows how long UAS has been happening.
show lre stat-service-error [*PORTS*]		Shows how long Link has been disconnected because of CPE turned off by user.

To display all errors that are counted during 15 minutes or one day, use the following command

Command	Mode	Description
show lre pre-15m-error [*PORTS*]	Enable Global Bridge	Shows the error status in previous 15 minutes.
show lre cur-15m-error [*PORTS*]		Shows the error status in current 15 minutes.
show lre pre-day-error [*PORTS*]		Shows the error status in previous day.
show lre cur-day-error [*PORTS*]		Shows the error status in current day

To reset data of CRC error, Frame loss and Signal loss, use the following command.

Command	Mode	Description
clear lre stat-crc-sec *PORTS*	Enable Global Bridge	Resets the data of error count.
clear lre stat-es-sec *PORTS*		
clear lre stat-ses-sec *PORTS*		
clear lre stat-lof-sec *PORTS*		
clear lre stat-los-sec *PORTS*		
clear lre stat-lol-sec *PORTS*		
clear lre stat-lpr-sec *PORTS*		
clear lre stat-uncorrectable-crc *PORTS*		

SES(Severely Errored Seconds) means how long server error has been happening, and UAS(Unavailable Seconds) means error, which SES is more than 10 seconds.

In addition, you can check how many minutes is passed after beginning 15 minutes (15 Min Elapse) or day (Day Elapse) based on the present time of checking how many times each port is disconnected and how long it is disconnected.

5.3.4 Config-Profile

You can make a policy configured in service port a Profile to apply to port. There are two kinds of profiles; one applied to VDSL line and the other one configured for Alarm of SNMP trap in case error is happened. This chapter describes the following lists.

- Line config profile
- Alarm config profile

5.3.4.1 Line config profile

Line config profile is a policy, which configures transmit rate of VDSL line, SNR margin, and Interleave-delay.

This is very useful when ISPs apply graded services. They do not have to configure all ports according to client's grade, but just apply profile to ports.

In switch, all VDSL ports are contained in one Line-config-profile. For the ports contained as the member port of Line-config-profile, it is not possible to change Interleave-delay or SNR margin. To change it, you should delete the member of Line-config-profile first.

If you try to configure interleave-delay of the port which is included as Line-config-profile member, the error message will be displayed.

```
SWITCH(bridge)# lre 5 interleave-delay 50
%VDSL Port 5 is line-config-profile DEFVAL member!
SWITCH(bridge)#
```

To configure Line config profile in detail, you need to open *Line-config Profile* mode. Use the following command.

Command	Mode	Description
line-config-profile *NAME*	Bridge	Opens line-config profile configuration mode. NAME: Line config profile name

The following is an example of entering into *Line-config Profile* mode to configure line config profile named as TEST.

```
SWITCH# config terminal
SWITCH(config)# bridge
SWITCH(bridge)# line-config-profile TEST
SWITCH(bridge-line-config-profile[TEST])#
```

Meanwhile, use the following command to exit from *Line-config Profile* mode

Command	Mode	Description
exit	Line-config	Exits from line config profile configuration mode.

To configure the detail of Profile, Use the following command.

Command	Mode	Description
down-max-inter-delay <1-100>	Line-config	Configures Interleave-delay of Downstream. The unit is msec.
down-slow-max-datarate <0-100000>		Configures transmit rate of Maximum Downstream. The unit is kbps. (1000=1Mbps)
down-slow-min-datarate <0-100000>		Configures transmit rate of Minimum Downstream. The unit is kbps. (1000=1Mbps)
down-target-snr-mgn <0-124>		Configures SNR margin of Downstream. The unit is 0.25dBm. (4=1dBm)
down-snr-min-mgn <0-124>		Configures minimum SNR margin of Downstream. The unit is 0.25dBm. (4=1dBm)
up-max-inter-delay <1-100>		Configures Interleave-delay of Upstream.
up-slow-max-datarate <0-100000>		Configures transmit rate of Maximum Upstream. The unit is kbps. (1000=1Mbps)
up-slow-min-datarate <0-100000>		Configures transmit rate of Minimum Upstream. The unit is kbps. (1000=1Mbps)
up-target-snr-mgn <0-124>		Configures SNR margin of Upstream. The unit is 0.25dBm. (4=1dBm)
up-snr-min-mgn <0-124>		Configures minimum SNR margin of Upstream. The unit is 0.25dBm. (4=1dBm)

The default of Interleave-delay is “2ms”, and speed of service is not configured by default setting. The default of SNR margin is “24(6dBm)” in case of Downstream, and “32(8dBm)” in case of Upstream.

Transmit rate should be configured using the unit of Mbps. Therefore, you can input in terms of 10000 in actual configuration.

The following is an example of configuring Interleave of profile named TEST as 20ms and transmit rate as 8M in case of Upstream and 10M in case of Downstream, and SNT margin as 10dBm.

```
SWITCH(bridge-line-config-profile[TEST])# down-max-inter-delay 20
SWITCH(bridge-line-config-profile[TEST])# up-max-inter-delay 20
SWITCH(bridge-line-config-profile[TEST])# down-slow-max-datarate 8000
SWITCH(bridge-line-config-profile[TEST])# up-slow-max-datarate 10000
SWITCH(bridge-line-config-profile[TEST])# down-target-snr-mgn 40
SWITCH(bridge-line-config-profile[TEST])# up-target-snr-mgn 40
SWITCH(bridge-line-config-profile[TEST])#
```

SNR margin should be configured with the form of NdBm(N=integer). Therefore you have to input multiple numbers of 4 to form NdBm.

To display the configuration, use the following command.

Command	Mode	Description
show lre line-config-profile [*PORTS*]	Enable/Global/Bridge	Shows the configuration of all line config profiles.

To enable configuration of this line-config profile, use the following command.

Command	Mode	Description
active	Line-config	Enables the profile.
no active		Disables this profile

Unless you enable configured profiles, they will not be applied although you apply them to ports.

After you configure and enable profile, if you change the configuration, then it will be automatically disabled. Therefore you have to enable it with "**active**" whenever you change configurations.

The following is an example of saving Profile after going back to Global configuration mode or Enable mode.

```
SWITCH(config)# write memory
Building configuration...
[OK]
SWITCH(config)#
```

Besides, when switch has been stacking, Line config profile configured in Master will be automatically configured in Slave. Although it is configured before stacking, Master's configuration will be configured in Slave by finding any difference. However, you have to save the configuration of Slave with using "**write memory**". Unless you do it, the configuration will be deleted and the above procedure will be repeated.

With enabled stacking, config profile of Master will be configured in Slave.

Apply Profile to port. Use the following command.

Command	Mode	Description
line-config-profile *NAME* **add** *PORTS*	Bridge	Applies Profile to specified port. NAME: line-config profile name

The following is an example of applying profile named TEST to port 1.

```
SWITCH(bridge)# line-config-profile TEST add 1
SWITCH(bridge)#
```

To disable the application of profile in specified port, use the following command.

Command	Mode	Description
line-config-profile *NAME* **del** *PORTS*	Bridge	Disables profile in specified port.

To delete configured profile, use the following command.

Command	Mode	Description
no line-config-profile *NAME*	Bridge	Deletes Profile.

5.3.4.2 Alarm config profile

Alarm config profile is a configured policy, which Alarm service is provided to clients with using SNMP trap in case of system error. It is convenient way because it is possible to configure standard of error checking, which varies according to service type, in each port. Alarm config profile consists of Threshold of error, which clients configure. Same as standard in 5.3.3 VDSL Checking Errors of VDSL Port each error is checked every 15 minutes, and SNMP trap is sent when it meets configured threshold.

To configure an alarm-config profile, perform the following steps.

Step 1
To configure alarm-config profile, you need to enter into *Alarm–config Profile* mode. Use the following command

Command	Mode	Description
alarm-config-profile *NAME*	Bridge	Opens alarm config profile mode NAME: alarm-config profile name

The following is an example of entering into *Alarm-config Profile* mode to configure alarm config profile named TEST

```
SWITCH# config terminal
SWITCH(config)# bridge
SWITCH(bridge)# alarm-config-profile TEST
SWITCH(bridge-alarm-config-profile[TEST])#
```

Meanwhile, use “exit” to exit from *Alarm-config Profile* mode.

Step 2
Configures detail of Profile. Use the following command.

Command	Mode	Description
thresh-15min-ess <0-900>	Alarm-Config	Configures duration of CRC, LOF, and LOS. The unit is second.
thresh-15min-lofs <0-900>		Configures threshold of duration of LOF. The unit is second.
thresh-15min-lols <0-900>		Configures threshold of duration of LOL. The unit is second.

Command	Mode	Description
thresh-15min-loss <0-900>	Alarm-Config	Configures threshold of duration of LOS. The unit is second.
thresh-15min-sess <0-900>		Configures threshold of duration of SES. The unit is second.
thresh-15min-uass <0-900>		Configures threshold of duration of UAS. The unit is second.

i If the threshold is configured as “0”, it means no limit. and the default of threshold is no limit.

The following is an example of configuring threshold of profile named TEST as 5 minutes (300 seconds).

```
SWITCH(bridge-alarm-config-profile[TEST])# thresh-15min-ess 300
SWITCH(bridge-alarm-config-profile[TEST])# thresh-15min-lofs 300
SWITCH(bridge-alarm-config-profile[TEST])# thresh-15min-lols 300
SWITCH(bridge-alarm-config-profile[TEST])# thresh-15min-loss 300
SWITCH(bridge-alarm-config-profile[TEST])# thresh-15min-sess 300
SWITCH(bridge-alarm-config-profile[TEST])# thresh-15min-uass 300
SWITCH(bridge-alarm-config-profile[TEST])#
```

To confirm the configuration, use the following command.

Command	Mode	Description
show lre alarm-config-profile [*PORTS*]	Enable/Global/Bridge	Shows the configuration of alarm-config profiles

The following is an example of confirming the above configuration.

```
SWITCH(bridge-alarm-config-profile[TEST])# show running-config
 (omitted)
 alarm-config-profile TEST
thresh-15min-lofs 300
  thresh-15min-loss 300
  thresh-15min-lols 300
  thresh-15min-ess 300
 (omitted)
SWITCH(bridge-alarm-config-profile[TEST])##
```

Step 3
Enables configurations. Unless you do it, they will not be applied to ports. To enable or disable configuration of Profile, use the following command.

Command	Mode	Description
active	Alarm-config	Enables this profile.
no active		Disables this profile

The following is an example of enabling configuration

```
SWITCH(bridge-alarm-config-profile[TEST])# active
SWITCH(bridge-alarm-config-profile[TEST])# show running-config
 (omitted)
 alarm-config-profile TEST
  thresh-15min-lofs 300
  thresh-15min-loss 300
  thresh-15min-lols 300
  thresh-15min-ess 300
  thresh-15min-sess 300
  thresh-15min-uass 300
  active
 (omitted)
SWITCH(bridge-line-config-profile[TEST])#
```

Unless you enable configured profiles, they will not be applied although you apply them to ports.

After you configure and enable profile, if you change the configuration, then it will be automatically disabled. Therefore you have to enable it with "**active**" whenever you change configurations.

Step 4
Save Profile after going back to Global configuration mode or Enable mode.

```
SWITCH(config)# write memory
Building configuration...
[OK]
SWITCH(config)#
```

Besides, when switch is been stacking, Alarm config profile configured in Master will be automatically configured in Slave. Although it is configured before stacking, Master's configuration will be configured in Slave by finding any difference. However, you have to save the configuration of Slave with using "**write memory**". Unless you do it, the configuration will be deleted and the above procedure will be repeated.

With enabled stacking, config profile of Master will be configured in Slave. it is impossible to configure alarm config profile in Slave.

Step 5
Apply Profile to port. Use the following command

Command	Mode	Description
alarm-config-profile *NAME* **add** *PORTS*	Bridge	Applies Profile to port

The following is an example of applying Profile named TEST to port 1.

```
SWITCH(bridge)# alarm-config-profile TEST add 1
SWITCH(bridge)#
```

With enabled stacking, Master's configuration is same configured in Slave. However, Master can make application to port of Slave. You should configure it in Slave. Please save the configuration after applying to port.

To disable the application of profile, use the following command.

Command	Mode	Description
alarm-config-profile *NAME* **del** *PORTS*	Bridge	Disables Profile applied to port.

Step 6
save the configuration.

```
SWITCH(config)# write memory
Building configuration...
[OK]
SWITCH(config)#
```

To delete Profile, use the following command.

Command	Mode	Description
no alarm-config-profile *NAME*	Bridge	Deletes Profile.

5.3.5 Configuring CPE

You can reset CPE used when switch and check state of CPE.

"PORTS" at CPE configuration command is VDSL port number connected specified CPE.

The below description is only for this switch, in which module is installed in DMT modulation.

This chapter describes the following lists.

- Modem Port Reset
- Installing System Image of CPE
- Installing CPE System Image File in Slave
- Configuring AGC (Auto Gain Control)
- Checking Length of Cable between CPE and CO
- Auto-negotiation of CPE
- Transmit Rate of CPE
- Duplex mode of CPE
- Auto Upgrade of CPE Image
- Displaying CPE Status

5.3.5.1 Modem Port Reset

When connection state of this switch and network is not normal, there may be some problem in modem port connection of CPE In this case, you can reset modem port of CPE. To reset modem port of CPE, use the following command.

Command	Mode	Description
cpe modem-reset *PORTS*	Bridge	Resets modem port of CPE.

The following is an example of resetting modem port of CPE connected to port 1

```
SWITCH(bridge)# cpe modem-reset 1
SWITCH(bridge)#
```

5.3.5.2 Installing System Image of CPE

You can install system image of CPE using command in this switch. After changing the name of system image file into that of single-file which is configured in internal system, install system image file in CPE. Perform the below steps to install system image file in CPE.

Step 1
Connect to FTP to store the CPE system image file in this switch.

To connect to FTP, please use the following command.

Command	Mode	Description
load ftp *DESTINATION*	Enable	Connects to FTP to store system image file in the system flash memory.

```
SWITCH# load ftp 172.16.232.1
Connected to 172.16.232.1.
220 FTP Server ready.
Name (172.16.232.1:root): anonymous
331 Password required for anonymous.
Password:anonymous@da-san.com
230 User qa logged in.
Remote system type is UNIX.
Using binary mode to transfer files.
```

Step 2
Store system image file as CPE of this switch by using the following command.

Command	Mode	Description
get *FILENAME*	Ftp	Stores system image file as CPE of this switch.

To download as binary mode, input "**bin**" command and input "**hash**" command to download as hash mark. The following exemple shows how to store CPE file.

```
ftp> bin
200 Type set to I.
ftp> hash
Hash mark printing on (1024 bytes/hash mark).
ftp> get cpe
local: cpe remote: cpe
200 PORT command successful.
150 Opening BINARY mode data connection for cpe (464228 bytes).
##################################################################################
##################################################################################
##############################################################
226 Transfer complete.
464228 bytes received in 0 secs (1600 Kbytes/sec)
ftp>
```

Step 3
After exiting from FTP, change the name of system image file of CPE in stored in this switch into name of configured single file.

To change into the name of single file , please use the following command.

Command	Mode	Description
store cpe-nos *FILENAME*	Bridge	Stores system image file in CPE.

The following is an example to change the name of CPE file into single file name after exiting from FTP.

i Input the port number connected to CPE which is supposed to install system image.

Step 4
Install the system image file to the CPE.

Command	Mode	Description
cpe nos-download *PORTS*	Bridge	Upgrades the system image file of CPE, which is connected through a port.

Step 5

To set the active OS of the CPE system, use the following command.

Command	Mode	Description
cpe nos-active *PORTS* {**os1** | **os2**}	Bridge	Sets the default OS of the system.

To display the version of CPE system image and active OS, use the following command.

Command	Mode	Description
show cpe-version [*PORTS*]	Enable Global Bridge	Shows the version and active software image of CPE, which is connected with a port. PORT: VDSL port number

Step 6
Reboot the CPE in which new system image file is installed.

5.3.5.3 Installing CPE System Image File in Slave

With staking configured in this switch, you can install system image file in Slave after new system image file of CPE is saved in Master RAM.

To install CPE system image file in Slave. Perform the below steps.

Step 1
Connect to Slave from Master.

```
SWITCH(bridge)# rcommand 2
Trying 127.1.0.2...
Connected to 127.1.0.2.
Escape character is '^]'.

SWITCH login: root
Password:
SWITCH#
```

Step 2
Connect to FTP of Master to bring new system image file of CPE stored in Master RAM.

Command	Mode	Description
load ftp *DESTINATION*	Enable	Connects to FTP of Master.

The following is an example of connecting to FTP of Master, 127.1.0.1.

```
SWITCH# config terminal
SWITCH(config)# bridge
SWITCH(bridge)# load ftp 127.1.0.1
Connected to 127.1.0.1.
220 FTP Server 1.2.4 (FTPD)
Name (127.1.0.1:root): root
331 Password required for root.
Password:
230 User root logged in.
Remote system type is UNIX.
Using binary mode to transfer files.
ftp>
```

Step 3
Store system image file as CPE of this switch by using the following command.

Command	Mode	Description
get *FILENAME*	Ftp	Store system image file as CPE of this switch.

To download as binary mode, input "**bin**" command and input "**hash**" command to download as hash mark. The following example shows how to store CPE file.

```
ftp> cd /
ftp> bin
200 Type set to I.
ftp> hash
Hash mark printing on (1024 bytes/hash mark).
ftp> get cpe
200 PORT command successful.
150 Opening BINARY mode data connection for cpe (464228 bytes).
################################################################################
################################################################################
################################################################################
################################################################################
################################################################################
################################################
################
226 Transfer complete.
464228 bytes received in 0 secs (1600 Kbytes/sec)
ftp>
```

Step 4
Exit from FTP server.

```
ftp> bye
221 Goodbye.
SWITCH#
```

Step 5
After exiting from FTP, change the name of system image file of CPE stored in this switch into the single file name.

To change into the single file name, please use the following command.

Command	Mode	Description
store cpe-nos *FILENAME*	Enable	Stores system image file in CPE.

The following is and example to change the name of CPE files into single file name after exiting from FTP.

```
ftp> exit
221 Goodbye.
SWITCH# store cpe-nos cpe
SWITCH#
```

i Input the port number connected to CPE which is supposed to install system image.

Step 6
Install the system image file to the CPE.

Command	Mode	Description
cpe nos-download *PORTS*	Bridge	Installs the system image file to a CPE, which is connected through a port.

Step 7
Reboot the CPE in which new system image file is installed.

5.3.5.4 Configuring AGC (Auto Gain Control)

AGC is the function of lengthen the communication distance. By using this function, it is possible to communicate in 140m. Therefore, it is better to use this function in the case the distance from CPE to the user is over 100m. To enable AGC in CPE, use the following command.

Command	Mode	Description
cpe agc-on *PORTS*	Bridge	Enables AGC in CPE.

To designate AGC and configure it manually, you should designate the distance. To disable the configured AGC, use the following command.

Command	Mode	Description
cpe {**agc-off-0** | **agc-off-1** | **agc-off-2** | **agc-off-3** | **agc-off-4** | **agc-off-5** | **agc-off-6** | **agc-off-7** | **agc-off-8** | **agc-off-9** | **agc-off-10**} *PORTS*	Bridge	Disable AGC in CPE and configure the distance manually.

i There can be some error in manually designated distance.

5.3.5.5 Checking Length of Cable between CPE and CO

To check cable length from CO to CPE, use the following command.

Command	Mode	Description
show lre ewl *PORTS*	Enable/Global/Bridge	Checks cable length from CO to CPE

5.3.5.6 Auto-negotiation of CPE

To enable or disable the auto negotiation of CPE Ethernet port, use the following command.

Command	Mode	Description
cpe nego *PORTS* **on**	Bridge	Enables the auto-negotiation on CPE ethernet port. (default: on)
cpe nego *PORTS* **off**		Disables the auto-negotiation CPE ethernet port

5.3.5.7 Transmit Rate of CPE

To set the transmit rate of an Ethernet port of CPE, use the following command.

Command	Mode	Description
cpe speed *PORTS* {**10** | **100**}	Bridge	Sets the transmit rate of the CPE ethernet port to 10/100 Mbps,

5.3.5.8 Duplex mode of CPE

To set the duplex mode on an Ethernet port of CPE, use the following command.

Command	Mode	Description
cpe duplex *PORTS* {**full** | **half**}	Bridge	Sets full-duplex or half-duplex mode on Ethernet port of CPE.

5.3.5.9 Auto Upgrade of CPE Image

To upgrade the CPE image automatically, use the following command.

Command	Mode	Description
cpe auto-upgrade enable {**h310** | **h320** | **h330** | **h335**} *VERSION*	Bridge	Enables the auto upgrading of CPE image for specific target model. VERSION: source cpe version (ex: 0.0.0r0)
cpe auto-upgrade disable		Disables the auto upgrading of CPE image.

5.3.5.10 Displaying CPE Status

You can check state of CPE connected to VDSL port. To display status of CPE, use the following command.

Command	Mode	Description
show cpe [*PORTS*]	Enable Global Bridge	Shows state of CPE
show cpe ethernet [*PORTS*]		Show the configurations of CPE Ethernet ports.
show cpe-info [*PORTS*]		Shows detailed H/W information of CPE
show cpe-version [*PORTS*]		Shows the version and active software image of CPE.
show cpe auto-upgrade [*PORTS*]		Shows the status of auto upgrading of CPE.

The following is an example of checking state of CPE connected to port 1-5.

```
SWITCH(config)# show cpe 1-5
--------------------------------------------------------------------------------
No      NOS Version    NOS       Ethernet Status
                    Download   Link   Speed   Duplex   Loopback   Agc
--------------------------------------------------------------------------------
1    1.0.3r29IK105012  Yes  21%   Down    10    Half   Disable    agc-off-1
2    1.0.3r29IK105012  Yes  21%   Down    10    Half   Disable    agc-off-1
3    1.0.3r29IK105012  Yes  21%   Down    10    Half   Disable    agc-off-1
4    1.0.3r29IK105012  Yes  21%   Down    10    Half   Disable    agc-off-1
5    1.0.3r29IK105012  Yes  20%   Down    10    Half   Disable    agc-off-1


SWITCH(config)# show cpe-info 1-5
--------------------------------------------------------------------------------
No       NOS Version   Vendor-ID  Vendor-STR  Model-Name     Serial-No
--------------------------------------------------------------------------------
1  1.0.3r29IK105012   0x0000fee8    DSNW      H335      000DPW/UO000346
2  1.0.3r29IK105012   0x0000fee8    DSNW      H335
3  1.0.3r29IK105012   0x0000fee8    DSNW      H335
4  1.0.3r29IK105012   0x0000fee8    DSNW      H335      000DPW/UO000348
5  1.0.3r29IK105012   0x0000fee8    DSNW      H335      000DPW/UO000341

SWITCH(config)#
```

i NOS Version means the current image. It will be updated after resetting when you install new image.

In the above example, NOS Download is indicated as the below.

Feature	Command
NO	NOS is not downloaded yet.
Yes	NOS is being downloaded.
Done	NOS has been successfully downloaded.
Fail	NOS downloading is failed.

Tab. 5.9 NOS Download

5.4 Port Mirroring

Port mirroring is the function of monitoring a designated port. Here, one port to monitor is called monitor port and a port to be monitored is called mirrored port. Traffic transmitted from mirrored port are copied and sent to monitor port so that user can monitor network traffic.

The following is a network structure to analyze the traffic by port mirroring. It analyzes traffic on the switch and network status by configuring Mirrored port and Monitor port connecting the computer, that the watch program is installed, to the port configured as Monitor port.

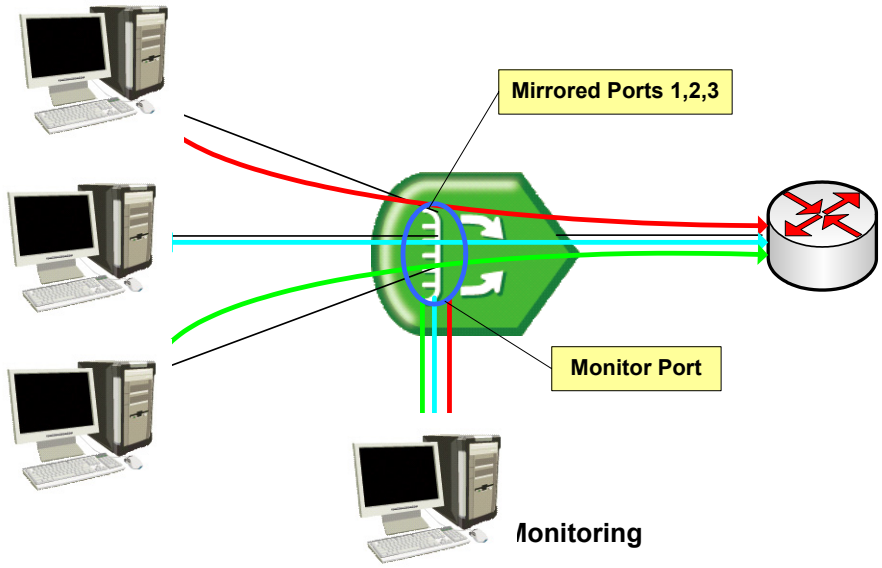


Fig. 5.5 Port Mirroring

To configure port mirroring, designate mirrored ports and monitor port. Then enable port mirroring function. Monitor port should be connected to the watch program installed PC. You can designate only one monitor port but many mirrored ports for one switch.

Step 1
Activate the port mirroring, using the following command.

Command	Mode	Description
mirror enable	Bridge	Activates port mirroring.

Step 2
Designate the monitor port, use the following command.

Command	Mode	Description
mirror monitor {*PORTS* | **cpu**}	Bridge	Designates the monitor port.

Step 3
Designate the mirrored ports, use the following command.

Command	Mode	Description
mirror add *PORTS* [**ingress** | **egress**]	Bridge	Designates the mirrored ports. ingress: ingress traffic egress: egress traffic

Step 4
To delete and modify the configuration, use the following command.

Command	Mode	Description
no mirror monitor	Bridge	Deletes a designated monitor port.
mirror del *PORTS* [**ingress** | **egress**]		Deletes a port from the mirrored port.

Step 5
To disable monitoring function, use the following command.

Command	Mode	Description
mirror disable	Bridge	Deactivate monitoring.

To display a configured port mirroring, use the following command.

Command	Mode	Description
show mirror	Enable Global Bridge	Shows a configured port mirroring.

The following is an example of enabling the port mirroring on the port 2 and 3 with the monitoring port 1.

```
SWITCH(bridge)# mirror enable
SWITCH(bridge)# mirror monitor 1
SWITCH(bridge)# mirror add 2-3
SWITCH(bridge)# show mirror

Mirroring enabled
 Monitor port = 1
 Ingress mirrored ports
 -- 02 03 -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
- --
 Egress mirrored ports
 -- 02 03 -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
-- -

SWITCH(bridge)#
```

6 System Environment

6.1 Environment Configuration

You can configure a system environment of the this switch with the following items:

- Host Name
- Time and Date
- Time Zone
- Network Time Protocol (NTP)
- Simple Network Time Protocol (SNTP)
- Terminal Configuration
- Login Banner
- DNS Server
- Fan Operation
- Disabling Daemon Operation
- FTP Server
- FTP Client address
- System Threshold

6.1.1 Host Name

Host name displayed on prompt is necessary to distinguish each device connected to network. To set a new host name, use the following command.

Command	Mode	Description
hostname *NAME*	Global	Creates a host name of the switch, enter the name.
no hostname [*NAME*]		Deletes a configured host name, enter the name.

The following is an example of changing host name to *TEST*.

```
SWITCH(config)# hostname TEST
TEST(config)#
```

6.1.2 Time and Date

To set system time and date, use the following command.

Command	Mode	Description
clock *DATETIME*	Enable	Sets system time and date.
show clock	Enable Global Bridge	Shows system time and date.

6.1.3 Time Zone

The switch provides three kinds of time zone, GMT, UCT and UTC. The time zone of the switch is predefined as GMT (Greenwich Mean Time). Also you can set the time zone where the network element belongs.

To set the time zone, use the following command (refer to the below table).

Command	Mode	Description
time-zone *TIMEZONE*	Global	Sets the time zone.
clear time-zone		Resets the time zone

To display the time zone, use the following command (refer to the below table).

Command	Mode	Description
show time-zone	Enable / Global /Bridge	Shows the world time zone map.

Tab. 6.1 shows the world time zone.

Time Zone	Country/City	Time Zone	Country/City	Time Zone	Country/City
GMT-12	Eniwetok	**GMT-3**	Rio De Janeiro	**GMT+6**	Rangoon
GMT-11	Samoa	**GMT-2**	Maryland	**GMT+7**	Singapore
GMT-10	Hawaii, Honolulu	**GMT-1**	Azores	**GMT+8**	Hong Kong
GMT-9	Alaska	**GMT+0**	London, Lisbon	**GMT+9**	Seoul, Tokyo
GMT-8	LA, Seattle	**GMT+1**	Berlin, Rome	**GMT+10**	Sydney,
GMT-7	Denver	**GMT+2**	Cairo, Athens	**GMT+11**	Okhotsk
GMT-6	Chicago, Dallas	**GMT+3**	Moscow	**GMT+12**	Wellington
GMT-5	New York, Miami	**GMT+4**	Teheran		
GMT-4	George Town	**GMT+5**	New Dehli		

Tab. 6.1 World Time Zone

To see a configured time zone, use the **show clock** command.

6.1.4 Network Time Protocol (NTP)

The network time protocol (NTP) provides a mechanism to synchronize time on computers across an internet. The specification for NTP is defined in RFC 1119. To enable/disable the NTP function, use the following command.

Command	Mode	Description
ntp server *SERVER1* [*SERVER2*] [*SERVER3*]	Global	Enables NTP function with a specified NTP server. SERVER: server IP address (maximum 3 servers)
no ntp server *SERVER1* [*SERVER2*] [*SERVER3*]		Deletes a specified NTP server. SERVER: server IP address
no ntp		Disables the NTP function.

To display a configured NTP, use the following command.

Command	Mode	Description
show ntp	Enable Global Bridge	Shows a configured NTP function.

To synchronize the system clock, the system periodically sends the NTP message to the NTP server. You can configure the system to bind the IP address to the message which allows the NTP server to recognize your system.

To bind the IP address to the NTP message, use the following command.

Command	Mode	Description
ntp bind-address *A.B.C.D*	Global	Specifies the IP address to be bound to the NTP message.
no ntp bind-address		Deletes a specified IP address.

6.1.5 Simple Network Time Protocol (SNTP)

NTP (Network Time Protocol) and SNTP (Simple Network Time Protocol) are the same TCP/IP protocol in that they use the same UDP time packet from the Ethernet Time Server message to compute accurate time. The basic difference in the two protocols is the algorithms being used by the client in the client/server relationship.

The NTP algorithm is much more complicated than the SNTP algorithm. NTP normally uses multiple time servers to verify the time and then controls the rate of adjustment or slew rate of the PC which provides a very high degree of accuracy. The algorithm determines if the values are accurate by identifying time server that doesn't agree with other time servers. It then speeds up or slows down the PC's drift rate so that the PC's time is always correct and there won't be any subsequent time jumps after the initial correction. Unlike NTP, SNTP usually uses just one Ethernet Time Server to calculate the time and then it "jumps" the system time to the calculated time. It can, however, have back-up Ethernet Time Servers in case one is not available.

To configure the switch in SNTP, use the following command.

Command	Mode	Description
sntp *SERVER1* [*SERVER2*] [*SERVER3*]	Global	Specifies the IP address of the SNTP server. It is possible up to three number of servers. SERVER: server IP address
no sntp *SERVER1* [*SERVER2*] [*SERVER3*]		Disables specific SNTP server.
no sntp		Disables SNTP function.

You can configure up to 3 servers so that you use second and third servers as backup use in case the first server is down.

To display SNTP configuration, use the following command.

Command	Mode	Description
show sntp	Enable Global Bridge	Show SNTP configuration.

The following is to register SNTP server as 203.255.112.96 and enable it.

```
SWITCH(config)# sntp 203.255.112.96
SWITCH(config)# show sntp
==========================
 sntpd is running.
==========================
 Time Servers
--------------------------
 1st : 203.255.112.96
==========================
SWITCH(config)#
```

6.1.6 Terminal Configuration

By default, the switch is configured to display 24 lines composed by 80 characters on console terminal. You can change the number of displayed lines by using the command, **terminal length**. The maximum line displaying is 512 lines.

To set the number of the lines displaying on terminal screen, use the following command.

Command	Mode	Description
terminal length <0-512>	Enable	Sets the number of the lines displaying on a terminal screen, enter the value.
no terminal length		Restores a default line displaying.

6.1.7 Login Banner

It is possible to set system login and log-out banner. Administrator can leave a message to other users with this banner.

To set system login and log-out banner, use the following command.

Command	Mode	Description
banner	Global	Sets a banner before login the system.
banner login		Sets a banner when successfully log in the system.
banner login-fail		Sets a banner when failing to login the system.

To restore a default banner, use the following command.

Command	Mode	Description
no banner	Global	Restores a default banner.
no banner login		
no banner login-fail		

To display a current login banner, use the following command.

Command	Mode	Description
show banner	Enable Global Bridge	Shows a current login banner.

6.1.8 DNS Server

To set a DNS server, use the following command.

Command	Mode	Description
dns server *A.B.C.D*	Global	Sets a DNS server.
no dns server *A.B.C.D*		Removes a DNS server.

To display a configured DNS server, use the following command.

Command	Mode	Description
show dns	Enable Global Bridge	Shows a configured DNS server.

If a specific domain name is registered instead of IP address, user can do telnet, FTP, TFTP and ping command to the hosts on the domain with domain name.

To search domain name, use the following command.

Command	Mode	Description
dns search *DOMAIN*	Global	Searches a domain name.
no dns search *DOMAIN*		Removes a domain name.

It is possible to delete DNS server and domain name at the same time with the below command.

Command	Mode	Description
no dns	Global	Deletes DNS server and domain name.

6.1.9 Fan Operation

For the switch, it is possible to control fan operation. To control fan operation, use the following command.

Command	Mode	Description
fan operation {**on** | **off**}	Global	Configures fan operation.

i It is possible to configure to start and stop fan operation according to the system temperature. To configure this, see Section 6.1.13.3.

To display fan status and the temperature for fan operation, use the following command.

Command	Mode	Description
show status fan	Enable Global Bridge	Shows the fan status and the temperature for the fan operation.

6.1.10 Disabling Daemon Operation

You can disable the daemon operation unnecessarily occupying CPU. To disable certain daemon operation, use the following command.

Command	Mode	Description
halt *PID*	Enable	Disables the daemon operation.

You can display the PID of each running processs with the **show process** command.

```
SWITCH# show process
USER     PID  %CPU  %MEM     VSZ   RSS  TTY   STAT   START  TIME  COMMAND
admin      1   0.2   0.2    1448   592  ?     S      Feb23  0:05  init [3]
admin      2   0.0   0.0       0     0  ?     S      Feb23  0:00  [keventd]
admin      3   0.0   0.0       0     0  ?     SN     Feb23  0:00  [ksoftirqd_CPU0]
admin      4   0.0   0.0       0     0  ?     S      Feb23  0:00  [kswapd]
admin      5   0.0   0.0       0     0  ?     S      Feb23  0:00  [bdflush]
admin      6   0.0   0.0       0     0  ?     S      Feb23  0:00  [kupdated]
admin      7   0.0   0.0       0     0  ?     S      Feb23  0:00  [mtdblockd]
admin      8   0.0   0.0       0     0  ?     S<     Feb23  0:00  [bcmDPC]
admin      9   0.0   0.0       0     0  ?     S<     Feb23  0:29  [bcmCNTR.0]
admin     16   0.0   0.0       0     0  ?     SN     Feb23  0:00  [jffs2_gcd_mtd0]
admin     81   0.0   2.0   10524  5492  ?     S      Feb23  0:53  /usr/sbin/swchd
admin     83   0.0   1.5    6756  3756  ?     S      Feb23  0:53  /usr/sbin/nsm

(Omitted)

SWITCH#
```

6.1.11 FTP Server

FTP server is enabled on this switch by default. But this configuration can’t provide the security serveice becaue it’s easy to access to the port of #23 by others. If the default

configuration is unnecessary on sysem, user can disable the system as FTP server.

To enable/disable the system of this switch as FTP server, use the following command.

Command	Mode	Description
ftp server {**enable** | **disable**}	Global	Enables/disables the FTP server on the system. (default: enable)

If the FTP server is disabled, the system software upgrade cannot be done via FTP server.

6.1.12 FTP Client address

You can specify several IP addresses to this switch. However, you can also specify one IP address when this switch has access to FTP server as a client

To assign source IP address that uses when this switch has access to FTP server as a client, use the following command.

Command	Mode	Description
ftp bind-address *A.B.C.D*	Global	Specifies an IP address to bind it to be the ftp client.
no ftp bind-address		Deletes a specified IP address as the ftp client

Please be careful that the FTP bind-address is also applied to TFTP server's bind-address.

6.1.13 System Threshold

You can configure the system with various kinds of the system threshold such as CPU load, traffic, temperature, etc. Using this threshold, the switch generates syslog messages, sends SNMP traps, or performs a relevant procedure.

6.1.13.1 CPU Load

To set the threshold of CPU load, use the following command.

Command	Mode	Description
threshold cpu <21-100> {**5** | **60** | **600**} [<20-100> {**5** | **60** | **600**}]	Global	Sets the threshold of CPU load in the unit of percent (%). 21-100: CPU load high (default: 50) 20-100: CPU load low 5 | 60 | 600: time interval (second)
no threshold cpu		Deletes the configured threshold of CPU load.

To show the configured threshold of CPU load, use the following command.

Command	Mode	Description
show cpuload	Enable Global Bridge	Shows the configured threshold of CPU load.
show cpu-trueload		Shows the CPU usage every 5 seconds during current 10 minutes.

6.1.13.2 Port Traffic

To set the threshold of port traffic, use the following command.

Command	Mode	Description
threshold port *PORTS THRESHOLD* {**5** | **60** | **600**} {**rx** | **tx**}	Global	Sets the threshold of port traffic. PORTS: port number THRESHOLD: threshold value (unit: kbps) 5 | 60 | 600: time interval (unit: second)
no threshold port *PORTS* {**rx** | **tx**}		Deletes the configured threshold of port traffic.

i The threshold of the port is set to the maximum rate of the port as a default.

To set a timer to block incoming traffic through specific port, use the following command.

Command	Mode	Description
threshold port *PORTS* **block timer <**10-3600**>**	Global	Set a timer to block the traffic which goes over its threshold. 10-3600: expire timer (unit: second)
no threshold port *PORTS* **block**		Deletes the configured threshold of port traffic.

To show the configured threshold of port traffic, use the following command.

Command	Mode	Description
show port threshold	Enable/Global/Bridge	Shows the configured threshold of port traffic.

6.1.13.3 Fan Operation

The system fan will operate depending on measured system temperature. To set the threshold of fan operation, use the following command.

Command	Mode	Description
threshold fan *START-TEMP STOP-TEMP*	Global	Sets the threshold of fan operation in the unit of Celsius (°C). START-TEMP: starts fan operation. (default: 30) STOP-TEMP: stops fan operation. (default: 0)
no threshold fan		Deletes a configured threshold of fan operation.

When you set the threshold of fan operation, *START-TEMP* must be higher than *STOP-TEMP*.

To show the configured threshold of fan operation, use the following command.

Command	Mode	Description
show status fan	Enable/Global/Bridge	Shows the status and configured threshold of fan operation.

6.1.13.4 System Temperature

To set the threshold of system temperature, use the following command.

Command	Mode	Description
threshold temp <-40-100>	Global	Sets the threshold of system temperature in the unit of centigrade (°C). -40-100: system temperature (default: 80)
no threshold temp		Deletes a configured threshold of system temperature.

To show the configured threshold of system temperature, use the following command.

Command	Mode	Description
show status temp	Enable Global Bridge	Shows the status and configured threshold of system temperature.

6.1.13.5 System Memory

To set the threshold of system memory in use, use the following command.

Command	Mode	Description
threshold memory <20-100>	Global	Sets the threshold of system memory in the unit of percent (%). 20-100: system memory in use
no threshold memory		Deletes the configured threshold of system memory.

6.1.13.6 SFP Module (optional uplink port)

The system module will operate depending on monitoring type of temperaturem, RX/TX power, voltage or Txbias. To set the threshold of module, use the following command.

Command	Mode	Description
threshold module {**rxpower** | **txpower**} {**alarm** | **warning**} *PORTS START-VALUE STOP-VALUE*	Global	Sets the Diagnostics threshold of SFP module by RX/TX power and monitors the module The range of RX/TX power: 0-6.5535 ㎽
threshold module temper {**alarm** | **warning**} *PORTS START-TEMP STOP-TEMP*		Sets the Diagnostics threshold of SFP module depending on temperature and monitors the module The range of temperature: -128～127.99℃
threshold module txbias {**alarm** | **warning**} *PORTS*		Sets the Diagnostics threshold of SFP module depending on txbias and monitors the module. The range of txbias: 0- 131 ㎖
threshold module voltage {**alarm** | **warning**} *PORTS*		Sets the Diagnostics threshold of SFP module depending on voltage and monitors the module The range of voltage: 0-6.5535 V

To delete the threshld of module operation depending on specified monitoring type, use the following command.

Command	Mode	Description
no threshold module {**rxpower** | **voltage** | **txbias** | **txpower** | **temper**} {**alarm** | **warning**} *PORTS*	Global	Deletes the configured threshold of SFP module.

To display the configuration of SFP module of specific port, use the following command.

Command	Mode	Description
show port module-info [*PORTS*]	Enable Global Bridge	Displays the status of SFP module.

If you insert an SFP module including Diagnostic Monitoring Interface (DMI) into ports, you can see the real-time information about the ports such as transceiver type, length, connector type, and vendor information of the SFP. However, you might not want to see DMI polling information because it may result in CPU overload to collect DMI data via I^2C interface.

To enable or disable collecting DMI information from SFP mouldes, use the following command.

Command	Mode	Description
module dmi {**enable** | **disable**}	Global	Specifies whether to collect DMI information from SFP modules.

This module DMI command is enabled by default. Thus, if you don't want to get DMI information, configure this setting as disable.

If disabled, the switch does not show DMI information of the SFP ports when using the **show port module-info** command.

To display the configuration of DMI module, use the following command.

Command	Mode	Description
show module dmi	Enable Global Bridge	Displays the configuration result of DMI module.

This is an example of disabling the DMI module and displaying the setting result.

```
SWITCH(config)# module dmi disable
SWITCH(config)# show module dmi
----------------------------------------
    Module Diagnostics Monitoring
----------------------------------------
module diagnotics monitor(dmi) : disable
SWITCH(config)#
```

6.2 Configuration Management

You can verify if the system configurations are correct and save them in the system. This section contains the following functions.

- Displaying System Configuration
- Writing System Configuration
- Auto-Saving
- System Configuration File
- Restoring Default Configuration

6.2.1 Displaying System Configuration

To display the current running configuration of the system, use the following command.

Command	Mode	Description
show running-config	All	Shows a configuration of the system.
show running-config {**admin-flow** | **admin-policy** | **flow** | **arp** | **bridge** | **dns** | **full** | **host-name** | **login** | **qos** | **rmon-alarm** | **rmon-event** | **rmon-history** | **policer** | **policy** | **snmp** | **syslog** | **time-out** | **time-zone**}		Shows a configuration of the system with the specific option.

The following is an example to display the configuration of the syslog.

```
SWITCH# show running-config syslog
!
syslog start
syslog output info local volatile
syslog output info local non-volatile
!
SWITCH#
```

6.2.2 Writing System Configuration

If you change the configuration of the system, you need to save the changes in the system flash memory.

To write a current running configuration, use the following command.

Command	Mode	Description
write memory	All	Writes a current running configuration in the system flash memory.
write terminal	Enable	Shows a current running configuration on the terminal. (alias to the **show running-config** command)

When you use the **write memory** command, make sure there is no key input until **[OK]** message appears.

6.2.3 Auto-Saving

The switch supports the auto-saving feature, allowing the system to save the system configuration automatically. This feature prevents unsaved system configuration lost by unexpected system failure.

To allow the system to save the system configuration automatically, use the following command.

Command	Mode	Description
write interval <10-1440>	Global	Enables auto-saving with a given interval. 10-1440: auto-saving interval (unit: minute)
no write interval		Disables auto-saving.

6.2.4 System Configuration File

To copy a system configuration file, use the following command.

Command	Mode	Description
copy running-config {*FILENAME* | **startup-config**}	Enable	Copies a running configuration file. FILENAME: configuration file name startup-config: startup configuration file
copy startup-config *FILENAME*		Copies a startup configuration file. FILENAME: configuration file name.
copy *FILENAME* **startup-config**		Copies a specified configuration file to the startup configuration file. FILENAME: configuration file name
copy *FILENAME1 FILENAME2*		Copies a specified configuration file to another configuration file.

To back up a system configuration file using FTP or TFTP, use the following command.

Command	Mode	Description
copy {**ftp** | **tftp**} **config upload** {*FILENAME* | **startup-config**}	Enable	Uploads a file to FTP or TFTP server with the name configured by user.
copy {**ftp** | **tftp**} **config download** {*FILENAME* | **startup-config**}		Downloads a file from FTP or TFTP server with the name configured by user.
copy {**ftp** | **tftp**} **os upload** {**os1** | **os2**}		Uploads a file to ftp or FTP server with a name of os1 or os2.
copy {**ftp** | **tftp**} **os download** {**os1** | **os2**}		Downloads a file from FTP or TFTP server with a name of os1 or os2.

i To access FTP to back up the configuration or use the backup file, you should know FTP user ID and the password. To back up the configuration or use the file through FTP, you can recognize the file transmission because hash function is automatically turned on.

To delete a system configuration file, use the following command.

Command	Mode	Description
erase config *FILENAME*	Enable Global	Deletes a specified configuration file. FILENAME: configuration file name

To display a system configuration file, use the following command.

Command	Mode	Description
show startup-config	Enable Global Bridge	Shows a current startup configuration.
show config-list		Shows a list of configuration files.

6.2.5 Restoring Default Configuration

To restore a default configuration of the system, use the following command.

Command	Mode	Description
restore factory-defaults	Enable	Restores a factory default configuration.
restore layer2-defaults		Restores an L2 default configuration.

i After restoring a default configuration, you need to restart the system to initiate.

6.3 System Management

When there is any problem in the system, you must find what the problem is and its solution. Therefore you should not only be aware of a status of the system but also verify if the system is correctly configured.

This section describes the following functions with CLI command:

- Network Connection
- IP ICMP Source Routing
- Tracing Packet Route
- Displaying User Connecting to System
- MAC Table
- Running Time of System
- System Information
- System Memory Information
- Running Process
- Displaying System Image
- Displaying Installed OS
- Default OS
- Switch Status
- Tech Support Information
- System Boot Information

6.3.1 Network Connection

To verify if your system is correctly connected to the network, use the **ping** command. For IP network, this command transmits a message to internet control message protocol (ICMP). ICMP is an internet protocol that notifies fault situation and provides information on the location where IP packet is received. When the ICMP echo message is received at the location, its replying message is returned to the place where it came from.

To perform a ping test to verify network status, use the following command.

Command	Mode	Description
ping [*A.B.C.D*]	Enable	Performs a ping test to verify network status.

The followings are the available options to perform the **ping** command.

Items	Description
Protocol [ip]	Supports ping test. The default is IP.
Target IP address	Sends ICMP echo message by inputting IP address or host name of destination in order to verify network status.
Repeat count [5]	Sends ICMP echo message as many as count. The default is 5.
Datagram size [100]	Ping packet size. The default is 100 bytes.

Tab. 6.2 Options for Ping

Items	Description
Timeout in seconds [2]	It is considered as successful ping test if reply returns within the configured time interval. The default is 2 seconds.
Extended commands [n]	Shows the additional commands. The default is no.

Tab. 6.2 Options for Ping (Cont.)

The following is an example of ping test 5 times to verify network status with IP address 172.16.1.254.

```
SWITCH# ping
Protocol [ip]: ip
Target IP address: 172.16.1.254
Repeat count [5]: 5
Datagram size [100]: 100
Timeout in seconds [2]: 2
Extended commands [n]: n
PING 172.16.1.254 (172.16.1.254) 100(128) bytes of data.
Warning: time of day goes back (-394us), taking countermeasures.
108 bytes from 172.16.1.254: icmp_seq=1 ttl=255 time=0.058 ms
108 bytes from 172.16.1.254: icmp_seq=2 ttl=255 time=0.400 ms
108 bytes from 172.16.1.254: icmp_seq=3 ttl=255 time=0.403 ms
108 bytes from 172.16.1.254: icmp_seq=4 ttl=255 time=1.63 ms
108 bytes from 172.16.1.254: icmp_seq=5 ttl=255 time=0.414 ms
--- 172.16.1.254 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 8008ms
rtt min/avg/max/mdev = 0.058/0.581/1.632/0.542 ms
SWITCH#
```

When multiple IP addresses are assigned to the switch, sometimes you need to verify the connection status between the specific IP address and network status.

In this case, use the same process as ping test and then input the followings after extended commands. It is possible to verify the connection between specific IP address and network using the following command.

The following is the information to use ping test for multiple IP addresses.

Items	Description
Source address or interface	Designates the address where the relative device should respond in source ip address.
Type of service [0]:	The service filed of QoS (Quality Of Service) in Layer 3 application. It is possible to designate the priority for IP Packet.
Set DF bit in IP header? [no]	Decides whether Don't Fragment (DB) bit is applied to Ping packet or not. Default is no. If the user choose 'yes', when the packets pass through the segment compromised with the smaller data unit, it prevents the packet to be Fragment. Therefore there could be error message.
Data pattern [0xABCD]	Configures data pattern. Default is OxABCD.

Tab. 6.3 Options for Ping for Multiple IP Addresses

The following is to verify network status between 172.16.157.100 and 172.16.1.254 when IP address of the switch is configured as 172.16.157.100.

```
SWITCH# ping
Protocol [ip]:
Target IP address: 172.16.1.254
Repeat count [5]: 5
Datagram size [100]: 100
Timeout in seconds [2]: 2
Extended commands [n]: y
Source address or interface: 172.16.157.100
Type of service [0]: 0
Set DF bit in IP header? [no]: no
Data pattern [0xABCD]:
PATTERN: 0xabcd
PING 172.16.1.254 (172.16.1.254) from 172.16.157.100 : 100(128) bytes of data.
108 bytes from 172.16.1.254: icmp_seq=1 ttl=255 time=30.4 ms
108 bytes from 172.16.1.254: icmp_seq=2 ttl=255 time=11.9 ms
108 bytes from 172.16.1.254: icmp_seq=3 ttl=255 time=21.9 ms
108 bytes from 172.16.1.254: icmp_seq=4 ttl=255 time=11.9 ms
108 bytes from 172.16.1.254: icmp_seq=5 ttl=255 time=30.1 ms

--- 172.16.1.254 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 8050ms
rtt min/avg/max/mdev = 11.972/21.301/30.411/8.200 ms
SWITCH#
```

6.3.2 IP ICMP Source Routing

If you implement PING test to verify the status of network connection, ICMP request arrives at the final destination as the closest route according to the routing theory.

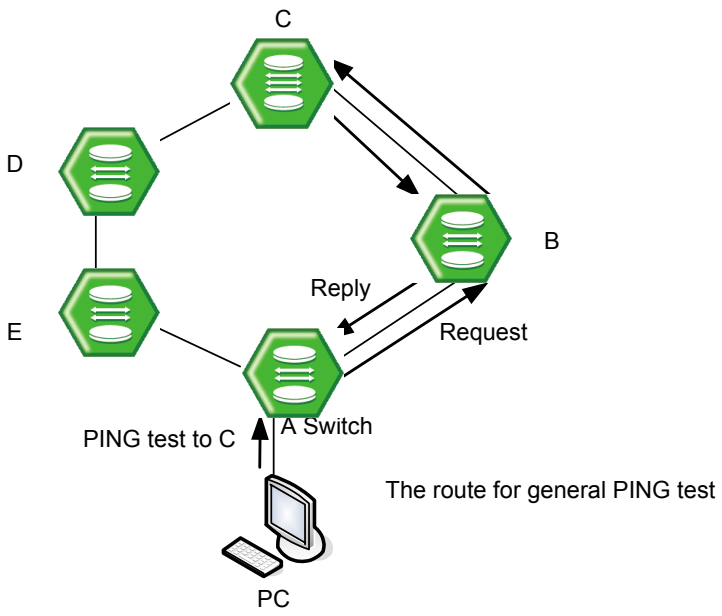


Fig. 6.1 Ping Test for Network Status

In the above figure, if you perform ping test from PC to C, it goes through the route of 「A→B→C」. This is the general case. But, the switch can enable to perform ping test from PC as the route of 「A→E→D→C」.

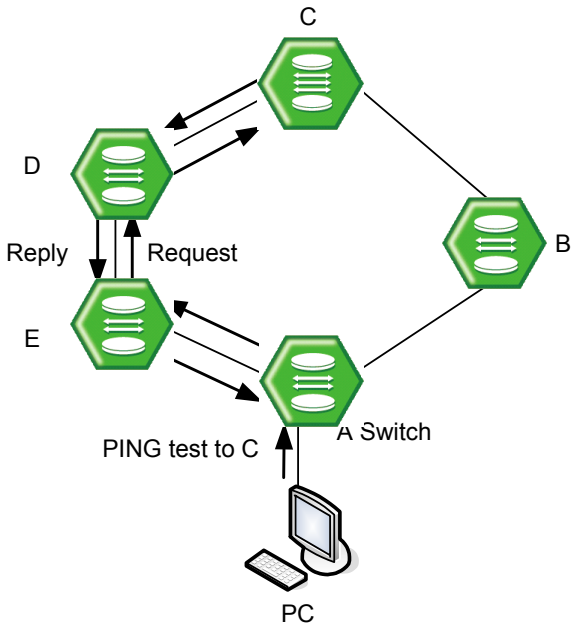


Fig. 6.2 IP Source Routing

To perform ping test as the route which the manager designated, use the following steps.

Step 1
Enable IP source-routing function from the equipment connected to PC which the PING test is going to be performed.

To enable/disable IP source-routing in the switch, use the following command.

Command	Mode	Description
ip icmp source-route	Global	Enable IP source-routing function.
no ip icmp source-route		Disable IP source-routing function.

Step 2
Perform the ping test from PC as the designate route with the **ping** command.

6.3.3 Tracing Packet Route

You can discover the routes that packets will actually take when traveling to their destinations. To do this, the **traceroute** command sends probe datagrams and displays the round-trip time for each node.

If the timer goes off before a response comes in, an asterisk (*) is printed on the screen.

Command	Mode	Description
traceroute [*DESTINATION*]	Enable	Traces packet routes through the network. DESTINATION: IP address or host name
traceroute ip *DESTINATION*		
traceroute icmp *DESTINATION*		

The followings are the configurable options to trace the routes.

Items	Description
Protocol [ip]	Supports ping test. Default is IP.
Target IP address	Sends ICMP echo message by inputting IP address or host name of destination in order to check network status with relative.
Source address	Source IP address which other side should make a response.
Numeric display [n]	Hop is displayed the number instead of indications or statistics.
Timeout in seconds [2]	It is considered as successful ping test if reply returns within the configured time interval. Default is 2 seconds.
Probe count [3]	Set the frequency of probing UDP packets.
Maximum time to live [30]	The TTL field is reduced by one on every hop. Set the time to trace hop transmission (The number of maximum hops). Default is 30 seconds.
Port Number [33434]	Selects general UDP port to be used for performing to trace the routes. The default is 33434.

Tab. 6.4 Options for Tracing Packet Route

The following is an example of tracing packet route sent to 10.1.158.158.

```
SWITCH# traceroute 10.27.41.81
traceroute to 10.27.41.81 (10.27.41.81), 30 hops max, 40 byte packets
 1  10.27.41.81 (10.27.41.81)  0.623 ms  0.295 ms  0.254 ms
SWITCH#
```

6.3.4 Displaying User Connecting to System

To display current users connecting to the system from a remote place or via console interface, use the following command.

Command	Mode	Description
where	Enable	Shows current users connecting to the system from a remote place or via console interface.

6.3.5 MAC Table

To display MAC table recorded in specific port, use the following command.

Command	Mode	Description
show mac *BRIDGE* [*PORTS*]	Enable Global Bridge	Shows MAC table. BRIDGE: bridge name PORTS: port number
show mac count [*PORTS*]		

The following is an example of displaying a current MAC table.

```
SWITCH(config)# show mac 1-3
=================================================================
port    mac addr            permission    status     in use
=================================================================
1     00:d0:cb:22:00:49    OK           dynamic      0.02
2     00:0b:5d:99:58:4c    OK           dynamic      4.95
3     00:0b:5d:51:3a:a8    OK           dynamic      6.05
SWITCH(config)#
```

6.3.6 Running Time of System

To display running time of the system, use the following command.

Command	Mode	Description
show uptime	Enable Global Bridge	Shows running time of the system.

The following is an example of displaying running time of the system.

```
SWITCH# show uptime
10:41am up 15 days, 10:55, 0 users, load average: 0.05, 0.07, 0.01
SWITCH#
```

6.3.7 System Information

To display the system information, use the following command.

Command	Mode	Description
show system	Enable Global Bridge	Shows the system information.

The following is an example of displaying the system information of the switch.

```
SWITCH# show system
```

```
    SysInfo(System Information)
Model Name         : SMC7824M/VSW
Main Memory Size    : 256 MB
Flash Memory Size   : 8 MB(SPANSION 29GL064N), 32 MB(SPANSION 29GL256N)
S/W Compatibility   : 7, 7
H/W Revision       : DS-VD-23N-B0
NOS Version        : 5.01
B/L Version        : 5.43
H/W Address        : 00:d0:cb:00:25:55
PLD Version        : 0x02
Serial Number      : RMK00981029384
Ikanos Firmware Ver : 1.0.5r39IK005010+FMC
```

6.3.8 System Memory Information

To display a system memory status, use the following command.

Command	Mode	Description
show memory	Enable Global Bridge	Shows system memory information.
show memory { **dhcp** | **imi** | **lib** | **nsm**}		Shows system memory information with a specific option.

6.3.9 Running Process

The switch provides a function that shows information of the running processes. The information with this command can be very useful to manage the switch.

To display information of the running processes, use the following command.

Command	Mode	Description
show process	Enable Global Bridge	Shows information of the running processes.

The following is an example of displaying information of the running processes.

```
SWITCH# show process
USER     PID  %CPU  %MEM     VSZ   RSS  TTY   STAT  START  TIME  COMMAND
admin      1   0.2   0.2    1448   592  ?     S     20:12  0:05  init [3]
admin      2   0.0   0.0       0     0  ?     S     20:12  0:00  [keventd]
admin      3   0.0   0.0       0     0  ?     SN    20:12  0:00  [ksoftirqd_CPU0]
admin      4   0.0   0.0       0     0  ?     S     20:12  0:00  [kswapd]
admin      5   0.0   0.0       0     0  ?     S     20:12  0:00  [bdflush]
admin      6   0.0   0.0       0     0  ?     S     20:12  0:00  [kupdated]
admin      7   0.0   0.0       0     0  ?     S     20:12  0:00  [mtdblockd]
admin      8   0.0   0.0       0     0  ?     SW<   20:12  0:00  [bcmDPC]
admin      9   1.4   0.0       0     0  ?     SW<   20:12  0:29  [bcmCNTR.0]
admin     10   1.4   0.0       0     0  ?     SW<   20:12  0:29  [bcmCNTR.1]
admin     17   0.0   0.0       0     0  ?     SWN   20:12  0:00  [jffs2_gcd_mtd3]
admin    149   0.0   0.3    1784   776  ?     S     Jan01  0:00  /sbin/syslogd -m
admin    151   0.0   0.2    1428   544  ?     S     Jan01  0:00  /sbin/klogd -c 1
```

```
admin    103   2.6   2.0   20552  5100  ?     S     20:12  0:53  /usr/sbin/swchd
(Omitted)
SWITCH#
```

6.3.10 Displaying System Image

To display a current system image version, use the following command.

Command	Mode	Description
show version	Enable/Global/Bridge	Shows a version of system image.

To display a size of the current system image, use the following command.

Command	Mode	Description
show os-size	Enable/Global/Bridge	Shows size of system image.

6.3.11 Displaying Installed OS

To display the current usage of the system flash memory, use the followng command.

Command	Mode	Description
show flash	Enable/Global/Bridge	Shows the current usage of the system flash memory.

6.3.12 Default OS

The switch supports the dual OS feature. You can verify the running OS in the flash memory with the **show flash** command. When two system OSs are installed, you can set one of those as the default OS. To set the default OS of the system, use the following command.

Command	Mode	Description
default-os {**os1** | **os2**}	Enable	Sets the default OS of the system. (default: os1)

6.3.13 Switch Status

To display the temperature of switch, power status, fan and external alarm status, use the following command.

Command	Mode	Description
show status fan	Enable Global Bridge	Shows fan status of switch.
show status power		Shows power status.
show status temp		Shows temperature of switch.
show status connector		Shows the type of connector of switch.
show external-alarm		Shows the current status of external alarms (#1 to #5)

6.3.14 Tech Support Information

For various reason, a system error may occur. Once the system error occurs, system engineers try to examine the internal system information such as a system configuration, log data, memory dump, and so on to solve the problem.

To reduce the effort to acquire the detail informtation of the system for a technical suppport, the switch provides the function that generates all the system information reflecting the current state. Using this function, you can verify all the details on a console screen or even in the remote place via FTP/TFTP.

To generate the tech-support information, use the following command.

Command	Mode	Description
tech-support {**all** | **crash-info**} **console**	Enable	Generates the tech-support information on a console screen.
tech-support {**all** | **crash-info**} **remote** *A.B.C.D* {**ftp** | **tftp**}		Generates the tech-support information in the remote place via FTP or TFTP. The name of the generated information file is **a.info**. (This is not changeable.)

In case of generating the tech-support information on a console screen, the contents will be displayed without the screen pause regardless of your terminal configuration.

6.3.15 System Boot Information

To display the information of the last system boot, use the following command.

Command	Mode	Description
show boot-info	Enable/Global/Bridge	Shows the information of the last system boot.

The following is the sample output of the **show boot-info** command after turn-on with the power switch.

```
SWITCH(config)# show boot-info
------------------------------------------------
 Type                   Date               Time
------------------------------------------------
POWERBOOT            ----/--/--         --:--:--

SWITCH(config)#
```

The following is the sample output of the **show boot-info** command after rebooting with the **reload** command.

```
SWITCH(config)# show boot-info

------------------------------------------------
 Type                   Date               Time
------------------------------------------------
SWREBOOT             2008/11/14         15:38:49

SWITCH(config)#
```

7 Network Management

7.1 Simple Network Management Protocol (SNMP)

The simple network management protocol (SNMP) is an application-layer protocol designed to facilitate the exchange of management information between network devices. SNMP consists of three parts: an SNMP manager, a managed device and an SNMP agent. SNMP provides a message format for sending information between SNMP manager and SNMP agent. The agent and MIB reside on the switch. In configuring SNMP on the switch, you define the relationship between the manager and the agent. According to community, you can give right only to read or right to both read and write. The SNMP agent has MIB variables to reply to requests from SNMP administrator. And SNMP administrator can obtain data from the agent and save data in the agent. The SNMP agent gets data from MIB, which saves information on system and network.

SNMP agent sends a trap to administrator for specific cases. Trap is a warning message to alert network status to SNMP administrator.

The switch enhances access management of SNMP agent and limits the range of OID opened to agents.

The following is how to configure SNMP.

- SNMP Community
- Information of SNMP Agent
- SNMP Com2sec
- SNMP Group
- SNMP View Record
- Permission to Access SNMP View Record
- SNMP Version 3 User
- SNMP Trap
- SNMP Alarm
- Displaying SNMP Configuration
- Disabling SNMP

7.1.1 SNMP Community

Only an authorized person can access SNMP agent by configuring SNMP community with a community name and additional information.

To configure SNMP community to allow an authorized person to access, use the following command.

Command	Mode	Description
snmp community {**ro** | **rw**} *COMMUNITY* [*A.B.C.D*] [*OID*]	Global	Creates SNMP community. COMMUNITY: community name
no snmp community {**ro** | **rw**} *COMMUNITY*		Deletes created community.

i You can configure up to 3 SNMP communities for each read-only and read-write.

To display configured SNMP community, use the following command.

Command	Mode	Description
show snmp community	Enable Global Bridge	Shows created SNMP community.

The following is an example of creating 2 SNMP communities.

```
SWITCH(config)# snmp community ro public
SWITCH(config)# snmp community rw private
SWITCH(config)# show snmp community

Community List
Type  Community        Source             OID
-----------------------------------------------
ro    public
rw    private

SWITCH(config)#
```

7.1.2 Information of SNMP Agent

You can specify the basic information of SNMP agent as administrator, location, and address that confirm its own identity.

To set the basic information of the SNMP agent, use the following command.

Command	Mode	Description
snmp contact *NAME*	Global	Sets the name of the administrator.
snmp location *LOCATION*		Sets the location of the SNMP agent.
snmp agent-address *A.B.C.D*		Sets an IP address of the SNMP agent.
no snmp contact		Deletes the specified basic information for each item.
no snmp location		
no snmp agent-address		

The following is an example of specifying basic information of SNMP agent.

```
SWITCH(config)# snmp contact Brad
SWITCH(config)# snmp location Germany
SWITCH(config)#
```

To display the basic information of the SNMP agent, use the following command.

Command	Mode	Description
show snmp contact	Enable Global Bridge	Shows the name of the administrator.
show snmp location		Shows the location of the SNMP agent.
show snmp agent-address		Shows the IP address of the SNMP agent.

7.1.3 SNMP Com2sec

SNMP v2 authorizes the host to access the agent according to the identity of the host and community name. The **com2sec** command specifies the mapping from the identity of the host and community name to security name.

To configure an SNMP security name, use the following command.

Command	Mode	Description
snmp com2sec *SECURITY* {*A.B.C.D* | *A.B.C.D/M*} *COMMUNITY*	Global	Specifies the mapping from the identity of the host and community name to security name, enter security and community name. SECURITY: security name COMMUNITY: community name
no snmp com2sec *SECURITY*		Deletes a specified security name, enter the security name. SECURITY: security name
show snmp com2sec	Enable Global Bridge	Shows a specified security name.

The following is an example of configuring SNMP com2sec.

```
SWITCH(config)# snmp com2sec TEST 10.1.1.1 PUBLIC
SWITCH(config)# show snmp com2sec

Com2Sec List
SecName          Source             Community
-------------------------------------------------
TEST             10.1.1.1           PUBLIC

SWITCH(config)#
```

7.1.4 SNMP Group

You can create an SNMP group that can access SNMP agent and its community that belongs to a group.

To create an SNMP group, use the following command.

Command	Mode	Description
snmp group *GROUP* {**v1** | **v2c** | **v3**} *SECURITY*	Global	Creates SNMP group, enter the group name. GROUP: group name SECURITY: security name
no snmp group *GROUP* [{**v1** | **v2c** | **v3**} [*SECURITY*]]		Deletes SNMP group, enter the group name. GROUP: group name
show snmp group	Enable Global	Shows a created SNMP group.

7.1.5 SNMP View Record

You can create an SNMP view record to limit access to MIB objects with object identity (OID) by an SNMP manager.

To configure an SNMP view record, use the following command.

Command	Mode	Description
snmp view *VIEW* {**included** | **excluded**} *OID* [*MASK*]	Global	Creates an SNMP view record. VIEW: view record name included: includes a sub-tree. excluded: excludes a sub-tree. OID: OID number
no snmp view *VIEW* [*OID*]		Deletes a created SNMP view record. VIEW: view record name

To display a created SNMP view record, use the following command.

Command	Mode	Description
show snmp view	Enable Global Bridge	Shows a created SNMP view record.

The following is an example of creating an SNMP view record.

```
SWITCH(config)# snmp view TEST included 410
SWITCH(config)# show snmp view

View List
ViewName        Type      SubTree / Mask
-----------------------------------------
TEST            included  410

SWITCH(config)#
```

7.1.6 Permission to Access SNMP View Record

To grant an SNMP group to access to a specific SNMP view record, use the following command.

Command	Mode	Description
snmp access *GROUP* {**v1** | **v2c**} *READ-VIEW WRITE-VIEW NOTIFY-VIEW*	Global	Grants an SNMP group to access a specific SNMP view record. GROUP: group name
snmp access *GROUP* **v3** {**noauth** | **auth** | **priv**} *READ-VIEW WRITE-VIEW NOTIFY-VIEW*		Grants an SNMP version 3 group to access a specific SNMP view record. GROUP: group name
no snmp access *GROUP*		Deletes a granted SNMP group to access a specific SNMP view record.

To display a granted SNMP group to access to a specific SNMP view record, use the following command.

Command	Mode	Description
show snmp access	Enable Global Bridge	Shows a granted SNMP group to access to a specific SNMP view record.

7.1.7 SNMP Version 3 User

In SNMP version 3, you can register an SNMP agent as user. If you register an SNMP version 3 user, you should configure it with the authentication key. To create/delete an SNMP version 3 user, use the following command.

Command	Mode	Description
snmp user *USER* {**md5** | **sha**} *AUTH_KEY* [**des** *PRIVATE_KEY*]	Global	Creates an SNMP version 3 user.
no snmp user *USER*		Deletes a registered SNMP version 3 user.

To display a current SNMP version 3 user, use the following command.

Command	Mode	Description
show snmp user	Enable Global Bridge	Displays an SNMP version 3 user.

7.1.8 SNMP Trap

SNMP trap is an alert message that SNMP agent notifies SNMP manager about certain problems. If you configure the SNMP trap, the system transmits pertinent information to network management program. In this case, trap message receivers are called a trap host.

7.1.8.1 SNMP Trap Mode

To select the SNMP trap mode, use the following command.

Command	Mode	Description
snmp trap-mode {**alarm-report** | **event**}	Global	Selects the SNMP trap mode. alarm-report: alarm report based trap event: event based trap (default)

- **“event” trap-mode** is set by default. It generates event based traps.
- **“alarm-report” trap-mode** generates alarm report based traps.

If you manage the system via the ACI-E, you should set the SNMP trap mode to the **alarm-report**.

7.1.8.2 SNMP Trap Host

To set an SNMP trap host, use the following command.

Command	Mode	Description
snmp trap-host *A.B.C.D* [*COMMUNITY*]	Global	Specifies an SNMP trap v1 host.
snmp trap2-host *A.B.C.D* [*COMMUNITY*]		Specifies an SNMP trap v2 host.
snmp inform-trap-host *A.B.C.D* [*COMMUNITY*]		Specifies an SNMP inform trap host.

To delete a specified SNMP trap host, use the following command.

Command	Mode	Description
no snmp trap-host *A.B.C.D*	Global	Deletes a specified SNMP trap v1 host.
no snmp trap2-host *A.B.C.D*		Deletes a specified SNMP trap v2 host.
no snmp inform-trap-host *A.B.C.D*		Deletes a specified SNMP inform trap host.

If you manage the system via the ACI-E, you should specify an SNMP trap v2 host with the **snmp trap2-host** command.

You can set maximum 16 SNMP trap hosts with inputting one by one.

The following is an example of setting an SNMP trap host.

```
SWITCH(config)# snmp trap-host 10.1.1.3
SWITCH(config)# snmp trap-host 20.1.1.5
SWITCH(config)# snmp trap-host 30.1.1.2
SWITCH(config)#
```

7.1.8.3 SNMP Trap in Event Mode

The system provides various kind of SNMP trap, but it may inefficiently work if all these trap messages are sent very frequently. Therefore, you can select each SNMP trap sent to an SNMP trap host.

- **auth-fail** is shown to inform wrong community is input when user trying to access to SNMP inputs wrong community.
- **cold-start** is shown when SNMP agent is turned off and restarts again.
- **link-up/down** is shown when network of port specified by user is disconnected, or when the network is connected again.
- **mem-threshold** is shown when memory usage exceeds the threshold specified by user. Also, when memory usage falls below the threshold, the trap message will be shown to notify it.
- **cpu-threshold** is shown when CPU utilization exceeds the threshold specified by user. Also, when CPU load falls below the threshold, trap message will be shown to notify it.
- **port-threshold** is shown when the port traffic exceeds the threshold configured by user. Also, when port traffic falls below the threshold, trap message will be shown.
- **temp-threshold** is shown when the system temperature exceeds the thresh-old con-

figured by user. Also, when system temperature falls below the threshold, trap message will be shown.

- **dhcp-lease** is shown when no more IP address is left in the DHCP pool. Even if this occurs only in one DHCP pool of several pools, this trap message will be shown.
- **fan/ module** is shown when there is any status-change of fan and module.

The system is configured to send all the SNMP traps by default.

To enable the SNMP trap, use the following command.

Command	Mode	Description
snmp trap auth-fail	Global	Configures the system to send SNMP trap when SNMP authentication is fail.
snmp trap cold-start		Configures the system to send SNMP trap when SNMP agent restarts.
snmp trap link-up *PORTS* [*NODE*]		Configures the system to send SNMP trap when a port is connected to network.
snmp trap link-down *PORTS* [*NODE*]		Configures the system to send SNMP trap when a port is disconnected from network.
snmp trap mem-threshold		Configures the system to send SNMP trap when memory usage exceeds or falls below the threshold.
snmp trap cpu-threshold		Configures the system to send SNMP trap when CPU load exceeds or falls below the threshold.
snmp trap port-threshold		Configures the system to send SNMP trap when the port traffic exceeds or falls below the threshold.
snmp trap temp-threshold		Configures the system to send SNMP trap when system temperature exceeds or falls below the threshold.
snmp trap dhcp-lease		Configures the system to send SNMP trap when no more IP address is left in the DHCP pool.
snmp trap fan		Configures the system to send SNMP trap when the fan begins to operate or stops.
snmp trap module		Configures the system to send SNMP trap when there is any problem in module.
snmp trap pps-control		Configures the system to send SNMP trap when the number of packets per second exceeds or falls below the PPS threshold.

7.1.8.4 Disabling SNMP Trap

To disable the SNMP trap, use the following command.

Command	Mode	Description
no snmp trap auth-fail	Global	Disables each SNMP trap.
no snmp trap cold-start		
no snmp trap link-up *PORTS* [*NODE*]		
no snmp trap link-down *PORTS* [*NODE*]		

Command	Mode	Description
no snmp trap mem-threshold	Global	Disables each SNMP trap.
no snmp trap cpu-threshold		
no snmp trap port-threshold		
no snmp trap temp-threshold		
no snmp trap dhcp-lease		
no snmp trap fan		
no snmp trap module		
no snmp trap pps-control		

7.1.8.5 Displaying SNMP Trap

To display the configuration of the SNMP trap, use the following command.

Command	Mode	Description
show snmp trap	Enable Global Bridge	Shows the configuration of SNMP trap.
show snmp alarm-report		Shows a collected alarm report based trap.

The following is an example of configuring the trap v1 host, trap v2 host and inform trap host.

```
SWITCH(config)# snmp trap-host 10.1.1.1
SWITCH(config)# snmp trap2-host 20.1.1.1
SWITCH(config)# snmp inform-trap-host 30.1.1.1
SWITCH(config)# show snmp trap

snmp trap mode:        event
----------------------------

Trap-Host List
Type              Host               Community
-----------------------------------------------
inform-trap-host 30.1.1.1
trap2-host       20.1.1.1
trap-host        10.1.1.1

Trap List
Trap-type       Status
--------------------------
auth-fail       enable
cold-start      enable
cpu-threshold   enable
port-threshold  enable
dhcp-lease      enable
power           enable
module          enable
fan             enable
temp-threshold  enable
mem-threshold   enable

SWITCH(config)#
```

7.1.9 SNMP Alarm

The switch provides an alarm notification function. The alarm will be sent to a SNMP trap host whenever a specific event in the system occurs through CLI. You can also set the alarm severity on each alarm and make the alarm be shown only in case of selected severity or higher. This enhanced alarm notification allows system administrators to manage the system efficiently.

7.1.9.1 Alarm Notify Activity

Normally the switch is supposed to generate an alarm only when a pre-defined event has occurred such as the fan fail, system restart, temperature high, etc. However, you can additionally configure the system to generate an alarm when any configuration parameter has been changed via CLI.

To enable/disable the alarm notify activity, use the following command.

Command	Mode	Description
snmp notify-activity {**enable** | **disable**}	Global	Enables/disables the alarm notify activity. (default: disable)

If you manage the system via the ACI-E, the alarm notify activity should be enabled.

7.1.9.2 Alarm Severity Criterion

You can set an alarm severity criterion to make an alarm be shown only in case of selected severity or higher. For example, if an alarm severity criterion has been set to **major**, you will see only an alarm whose severity is **major** or **critical**.

To set an alarm severity criterion, use the following command.

Command	Mode	Description
snmp alarm-severity criteria {**critical** | **major** | **minor** | **warning** | **intermediate**}	Global	Sets an alarm severity criterion. (default: warning)

The order of alarm severity is **critical** > **major** > **minor** > **warning** > **intermediate**.

The configured alarm severity criterion is valid only in ACI-E.

7.1.9.3 Default Alarm Severity

To set default alarm severity, use the following command.

Command	Mode	Description
snmp alarm-severity default {**critical** | **major** | **minor** | **warning** | **intermediate**}	Global	Sets default alarm severity. (default: minor)

7.1.9.4 Generic Alarm Severity

To set generic alarm severity, use the following command.

Command	Mode	Description
snmp alarm-severity fan-fail {**critical** | **major** | **minor** | **warning** | **intermediate**}	Global	Sets severity of an alarm for system fan failure.
snmp alarm-severity cold-start {**critical** | **major** | **minor** | **warning** | **intermediate**}		Sets severity of an alarm for system cold restart.
snmp alarm-severity broadcast-over {**critical** | **major** | **minor** | **warning** | **intermediate**}		Sets severity of an alarm for too much broadcast.
snmp alarm-severity cpu-load-over {**critical** | **major** | **minor** | **warning** | **intermediate**}		Sets severity of an alarm for CPU load high.
snmp alarm-severity dhcp-lease {**critical** | **major** | **minor** | **warning** | **intermediate**}		Sets severity of an alarm for no more IP address left in the DHCP pool.
snmp alarm-severity dhcp-illegal {**critical** | **major** | **minor** | **warning** | **intermediate**}		Sets severity of an alarm for illegal DHCP entry.
snmp alarm-severity fan-remove {**critical** | **major** | **minor** | **warning** | **intermediate**}		Sets severity of an alarm for system fan removed.
snmp alarm-severity ipconflict {**critical** | **major** | **minor** | **warning** | **intermediate**}		Sets severity of an alarm for IP address conflict.
snmp alarm-severity memory-over {**critical** | **major** | **minor** | **warning** | **intermediate**}		Sets severity of an alarm for system memory usage high.
snmp alarm-severity mfgd-block {**critical** | **major** | **minor** | **warning** | **intermediate**}		Sets severity of an alarm for MAC flood guard block.
snmp alarm-severity port-link-down {**critical** | **major** | **minor** | **warning** | **intermediate**}		Sets severity of an alarm for Ethernet port link down.
snmp alarm-severity port-remove {**critical** | **major** | **minor** | **warning** | **intermediate**}		Sets severity of an alarm for Ethernet port removed.
snmp alarm-severity port-thread-over {**critical** | **major** | **minor** | **warning** | **intermediate**}		Sets severity of an alarm for port thread over.
snmp alarm-severity power-fail {**critical** | **major** | **minor** | **warning** | **intermediate**}		Sets severity of an alarm for system power failure.
snmp alarm-severity power-remove {**critical** | **major** | **minor** | **warning** | **intermediate**}		Sets severity of an alarm for system power removed.
snmp alarm-severity rmon-alarm-rising {**critical** | **major** | **minor** | **warning** | **intermediate**}		Sets severity of an alarm for RMON alarm rising.

Command	Mode	Description
snmp alarm-severity rmon-alarm-falling {**critical** | **major** | **minor** | **warning** | **intermediate**}	Global	Sets severity of an alarm for RMON alarm falling.
snmp alarm-severity system-restart {**critical** | **major** | **minor** | **warning** | **intermediate**}		Sets severity of an alarm for system restart.
snmp alarm-severity module-remove {**critical** | **major** | **minor** | **warning** | **intermediate**}		Sets severity of an alarm for module removed.
snmp alarm-severity temperature-high {**critical** | **major** | **minor** | **warning** | **intermediate**}		Sets severity of an alarm for system temperature high.

To delete configured alarm severity, use the following command.

Command	Mode	Description
no snmp alarm-severity fan-fail	Global	Deletes configured alarm severity.
no snmp alarm-severity cold-start		
no snmp alarm-severity broadcast-over		
no snmp alarm-severity cpu-load-over		
no snmp alarm-severity dhcp-lease		
no snmp alarm-severity dhcp-illegal		
no snmp alarm-severity fan-remove		
no snmp alarm-severity ipconflict		
no snmp alarm-severity memory-over		
no snmp alarm-severity mfgd-block		
no snmp alarm-severity port-link-down		
no snmp alarm-severity port-remove		
no snmp alarm-severity port-thread-over		
no snmp alarm-severity power-fail		
no snmp alarm-severity power-remove		
no snmp alarm-severity rmon-alarm-rising		
no snmp alarm-severity rmon-alarm-falling		
no snmp alarm-severity system-restart		
no snmp alarm-severity module-remove		
no snmp alarm-severity temperature-high		

7.1.9.5 ADVA Alarm Severity

To set ADVA alarm severity, use the following command.

Command	Mode	Description
snmp alarm-severity adva-fan-fail {**critical** | **major** | **minor** | **warning** | **intermediate**}	Global	Sets ADVA severity of an alarm for system temperature high.
snmp alarm-severity adva-if-misconfig {**critical** | **major** | **minor** | **warning** | **intermediate**}		Sets ADVA severity of an alarm for wrong configuration.
snmp alarm-severity adva-if-opt-thres {**critical** | **major** | **minor** | **warning** | **intermediate**}		Sets ADVA severity of an alarm for traffic threshold over for an Ethernet optical interface.
snmp alarm-severity adva-if-rcv-fail {**critical** | **major** | **minor** | **warning** | **intermediate**}		Sets ADVA severity of an alarm for failure to receive packets.
snmp alarm-severity adva-if-trans-fault {**critical** | **major** | **minor** | **warning** | **intermediate**}		Sets ADVA severity of an alarm for failure to transmit packets.
snmp alarm-severity adva-if-sfp-mismatch {**critical** | **major** | **minor** | **warning** | **intermediate**}		Sets ADVA severity of an alarm for SFP module mismatched.
snmp alarm-severity adva-psu-fail {**critical** | **major** | **minor** | **warning** | **intermediate**}		Sets ADVA severity of an alarm for PSU failure.
snmp alarm-severity adva-temperature {**critical** | **major** | **minor** | **warning** | **intermediate**}		Sets ADVA severity of an alarm for system temperature high.
snmp alarm-severity adva-voltage-high {**critical** | **major** | **minor** | **warning** | **intermediate**}		Sets ADVA severity of an alarm for input voltage high.
snmp alarm-severity adva-voltage-low {**critical** | **major** | **minor** | **warning** | **intermediate**}		Sets ADVA severity of an alarm for input voltage low.

To delete configured ADVA alarm severity, use the following command.

Command	Mode	Description
no snmp alarm-severity adva-fan-fail	Global	Deletes configured ADVA alarm severity.
no snmp alarm-severity adva-if-misconfig		
no snmp alarm-severity adva-if-opt-thres		
no snmp alarm-severity adva-if-rcv-fail		
no snmp alarm-severity adva-if-sfp-mismatch		
no snmp alarm-severity adva-if-trans-fault		
no snmp alarm-severity adva-psu-fail		
no snmp alarm-severity adva-temperature		
no snmp alarm-severity adva-voltage-high		
no snmp alarm-severity adva-voltage-low		

7.1.9.6 ERP Alarm Severity

To set severity of an alarm for ERP, use the following command.

Command	Mode	Description
snmp alarm-severity erp-domain-lotp {**critical** | **major** | **minor** | **warning** | **intermediate**}	Global	Sets severity of an alarm for loss of test packet (LOTP) in ERP domain.
snmp alarm-severity erp-domain-multi-rm {**critical** | **major** | **minor** | **warning** | **intermediate**}		Sets severity of an alarm for multiple redundancy managers (RM) created.
snmp alarm-severity erp-domain-reach-fail {**critical** | **major** | **minor** | **warning** | **intermediate**}		Sets severity of an alarm for disconnection of ERP domain.
snmp alarm-severity erp-domain-ulotp {**critical** | **major** | **minor** | **warning** | **intermediate**}		Sets severity of an alarm for loss of test packet (LOTP) in ERP port.

To delete configured severity of an alarm for ERP, use the following command.

Command	Mode	Description
no snmp alarm-severity erp-domain-lotp	Global	Deletes configured severity of an alarm for ERP.
no snmp alarm-severity erp-domain-multi-rm		
no snmp alarm-severity erp-domain-reach-fail		
no snmp alarm-severity erp-domain-ulotp		

7.1.9.7 STP Guard Alarm Severity

To set severity of an alarm for STP guard, use the following command.

Command	Mode	Description
snmp alarm-severity stp-bpdu-guard {**critical** | **major** | **minor** | **warning** | **intermediate**}	Global	Sets severity of an alarm for BPDU guard disabled.
snmp alarm-severity stp-root-guard {**critical** | **major** | **minor** | **warning** | **intermediate**}		Sets severity of an alarm for root guard disabled.

To delete configured severity of alarm for STP guard, use the following command.

Command	Mode	Description
no snmp alarm-severity stp-bpdu-guard	Global	Deletes configured severity of an alarm for STP guard.
no snmp alarm-severity stp-root-guard		

7.1.9.8 Displaying SNMP Alarm Severity

To display configured severity of alarm, use the following command.

Command	Mode	Description
show snmp alarm-severity	Enable Global Bridge	Shows configured severity of alarm.

7.1.10 Displaying SNMP Configuration

To display all configurations of SNMP, use the following command.

Command	Mode	Description
show snmp	Enable Global Bridge	Shows all configurations of SNMP.

To deletes a recorded alarm in the system, use the following command.

Command	Mode	Description
snmp clear alarm-history	Global	Deletes a recorded alarm in the system.

7.1.11 Disabling SNMP

To disable SNMP, use the following command.

Command	Mode	Description
no snmp	Global	Disables SNMP.

When you use the **no snmp** command, all configurations of SNMP will be lost.

7.2 Operation, Administration and Maintenance (OAM)

In the enterprise, Ethernet links and networks have been managed via Simple Network Management Protocol (SNMP). Although SNMP provides a very flexible management solution, it is not always efficient and is sometimes inadequate to the task.

First, using SNMP assumes that the underlying network is operational because SNMP relies on IP connectivity; however, you need management functionality even more when the underlying network is non-operational. Second, SNMP assumes every device is IP accessible. This requires provisioning IP on every device and instituting an IP overlay network even if the ultimate end-user service is an Ethernet service. This is impractical in a carrier environment.

For these reasons, carriers look for management capabilities at every layer of the network. The Ethernet layer has not traditionally offered inherent management capabilities, so the IEEE 802.3ah Ethernet in the First Mile (EFM) task force added the Operations, Administration and Maintenance (OAM) capabilities to Ethernet like interfaces. These management capabilities were introduced to provide some basic OAM function on Ethernet media.

EFM OAM is complementary, not competitive, with SNMP management in that it provides some basic management functions at Layer 2, rather than using Layer 3 and above as required by SNMP over an IP infrastructure. OAM provides single-hop functionality in that it works only between two directly connected Ethernet stations. SNMP can be used to manage the OAM interactions of one Ethernet station with another.

7.2.1 OAM Loopback

For OAM loopback function, both the switch and the host should support OAM function. OAM loopback function enables Loopback function from the user's device to the host which connected to the user's device and operates it.

To enable/disable local OAM function, use the following command.

Command	Mode	Description
oam local admin enable *PORTS*	Bridge	Enables local OAM.
oam local admin disable *PORTS*		Disables local OAM.

To configure loopback function of the host connected to the switch, use the following command.

Command	Mode	Description
oam remote loopback enable *PORTS*	Bridge	Enables loopback function of peer device.
oam remote loopback disable *PORTS*		Disables loopback function of peer device.
oam remote loopback start *PORTS*		Operates loopback.

7.2.2 Local OAM Mode

To configure Local OAM, use the following command.

Command	Mode	Description
oam local mode {**active** | **passive**} *PORTS*	Bridge	Configures the mode of local OAM.

i Both request and loopback are possible for local OAM active. However, request or loopback is impossible for local OAM passive.

7.2.3 OAM Unidirection

When RX is impossible in local OAM, it is possible to send the information by using TX. To enable/disable the function, use the following command.

Command	Mode	Description
oam local unidirection enable *PORTS*	Bridge	Sends the information by using TX.
oam local unidirection disable *PORTS*		Disables to transmit the information by using TX.

7.2.4 Remote OAM

To configure remote OAM, use the following command.

Command	Mode	Description
oam remote oam admin <1-2> {**enable** | **disable**} *PORTS*	Bridge	Enables/disable remote OAM.
oam remote oam mode <1-2> {**active** | **passive**} *PORTS*		Selects remote OAM mode.

To display the information of peer host using OAM function, use the following command.

Command	Mode	Description
oam remote alarm optical <1-3> <0-65535> *PORTS*	Bridge	Shows the information of peer host using OAM function.
oam remote alarm temperature <0-255> *PORTS*		
oam remote alarm voltage {**min** | **max**} <0-65535> *PORTS*		
oam remote electrical mode {**full** | **half**} *PORTS*		
oam remote general autoneg <1-4> {**enable** | **disable**} *PORTS*		

Command	Mode	Description
oam remote general forwarding <3-4> {**enable** | **disable**} *PORTS*	Bridge	Shows the information of peer host using OAM function.
oam remote general speed <1-4> <0-4294967295>*PORTS*		
oam remote general user <1-4> *STRING PORTS*		
oam remote system interface {**unforced** | **forceA** | **forceB**} *PORTS*		
oam remote system interval <0-255> *PORTS*		
oam remote system mode {**master** | **slave**} *PORTS*		
oam remote system reset *PORTS*		

7.2.5 Displaying OAM Configuration

To display OAM configuration, use the following command.

Command	Mode	Description
show oam	Enable Global Bridge	Shows OAM configuration.
show oam local *PORTS*		Shows local OAM configuration.
show oam remote *PORTS*		Shows remote OAM configuration.
show oam remote variable <0-255> <0-255> *PORTS*		Shows remote OAM variable. 0-255: branch number 0-255: leaf number
show oam remote variable specific <0-255> <0-255> <0-4> *PORTS*		Shows remote OAM specific variable. 0-255: branch number 0-255: leaf number 0-4: instance number

The following is an example of enabling OAM loopback via port 2 of the switch and performing remote loopback.

```
SWITCH(bridge)# oam local admin enable 2
SWITCH(bridge)# oam remote loopback enable 2
SWITCH(bridge)# show oam local 2
  LOCAL PORT[2]
-----------------------------------------
      item       |     value
-----------------------------------------
  admin          |     ENABLE
  mode           |     ACTIVE
  mux action     |     FORWARD
  par action     |     DISCARD
  variable       |     UNSUPPORT
```

```
  link event      |     UNSUPPORT
  loopback        |     SUPPORT(disable)
  uni-direction   |     UNSUPPORT(disable)
-----------------------------------------
SWITCH(bridge)# show oam remote 2
  REMOTE PORT[2]
-----------------------------------------
       item       |     value
-----------------------------------------
  mode            |     ACTIVE
  MAC address     |     00:d0:cb:27:00:94
  variable        |     UNSUPPORT
  link event      |     UNSUPPORT
  loopback        |     SUPPORT(enable)
  uni-direction   |     UNSUPPORT
-----------------------------------------
SWITCH(bridge)# oam remote loopback start 2
PORT[2]: The remote DTE loopback is success.
SWITCH(bridge)#
```

7.3 Link Layer Discovery Protocol (LLDP)

Link Layer Discovery Protocol (LLDP) is the function of transmitting data for network management for the switches connected in LAN according to IEEE 802.1ab standard.

7.3.1 LLDP Operation

The switch supporting LLDP transmits the management information between near switches. The information carries the management information that can recognize the network elements and the function. This information is saved in internal Management Information Base (MIB).

When LLDP starts to operate, the switches send their information to near switches. If there is some change in local status, it sends their changed information to near switch to inform their status. For example, if the port status is disabled, it informs that the port is disabled to near switches. And the switch that receives the information from near switches processes LLDP frame and saves the information of the other switches. The information received from other switches is aged.

7.3.2 Enabling LLDP

To enable LLDP, use the following command.

Command	Mode	Description
lldp *PORTS* **mgmtaddr** *A.B.C.D*	Bridge	Enables LLDP function on a port. A.B.C.D: IP address that is given to LLDP packet
no lldp *PORTS* **mgmtaddr** *A.B.C.D*		Disables LLDP function.

7.3.3 LLDP Operation Type

If you activated LLDP on a port, configure LLDP operation type.

Each LLDP operation type works as one of the followings:
- **both** sends and receive LLDP frame.
- **tx_only** only sends LLDP frame.
- **rx_only** only receives LLDP frame.
- **disable** does not process any LLDP frame.

To configure how to operate LLDP, use the following command.

Command	Mode	Description
lldp adminstatus *PORTS* [**both** | **tx_only** | **rx_only** | **disable**]	Bridge	Configures LLDP operation type. (default: disable)

7.3.4 Basic TLV

LLDP is transmitted through TLV. There are mandatory TLV and optional TLV. In optional TLV, there are basic TLV and organizationally specific TLV. Basic TLV must be in the switch where LLDP is realized, specific TLV can be added according to the feature of the switch.

For the switch, the administrator can enable and disable basic TLV by selecting it. To enable basic TLV by selecting it, use the following command.

Command	Mode	Description
lldp *PORTS* [**portdescription** | **sysname** | **sysdescription** | **syscap**]	Bridge	Selects basic TLV that is sent in the port.
no lldp *PORTS* [**portdescription** | **sysname** | **sysdescription** | **syscap**]		Disables basic TLV configured to be sent in the port.

7.3.5 LLDP Message

For the switch, it is possible to configure the interval time and times of sending LLDP message. To configure the interval time and times of LLDP message, use the following command.

Command	Mode	Description
lldp msg txinterval <5-32768>	Bridge	Configures the interval of sending LLDP message. The unit is second. (default: 30)
lldp msg txhold <2-10>		Configures the periodic times of LLDP message. (default: 4)

i Default for sending LLDP message is 4 times in every 30 seconds.

7.3.6 Reinitiating Delay

To configure the interval time of enabling LLDP frame after configuring LLDP operation type, use the following command.

Command	Mode	Description
lldp reinitdelay <1-10>	Bridge	Configures the interval time of enabling LLDP frame from the time of configuring not to process LLDP frame. (default: 2)

To configure delay time of transmitting LLDP frame, use the following command.

Command	Mode	Description
lldp txdelay <1-8192>	Bridge	Configures delay time of transmitting LLDP frame. (default: 2)

7.3.7 Displaying LLDP Configuration

To display LLDP configuration, use the following command.

Command	Mode	Description
show lldp config [*PORTS*]	Enable Global Bridge	Shows LLDP configuration.
show lldp remote [*PORTS*]		Show statistics for remote entries.
show lldp statistics [*PORTS*]		Shows LLDP operation and statistics.

To delete an accumulated statistics on the port, use the following command.

Command	Mode	Description
clear lldp statistics [*PORTS*]	Enable Global Bridge	Deletes an accumulated statistics on the port.

The following is the sample output of the **show lldp config** command.

```
SWITCH(config)# show lldp config 1-2
GLOBL:
------------------------------------------------------------------------
MsgTxInterval    = 30
MsgTxHold        = 4    =>  txTTL = 120
ReInitDelay      = 2
TxDelay          = 2
------------------------------------------------------------------------
PORTS active  adminStat|    mgmtAddress|optTLVs
   1: disable   Tx<->Rx|           none|
   2: disable   Tx<->Rx|           none|
SWITCH(config)#
```

7.4 Remote Monitoring (RMON)

Remote Monitoring (RMON) is a function to monitor communication status of devices connected to Ethernet at remote place. While SNMP can give information only about the device mounting an SNMP agent, RMON gives network status information about overall segments including devices. Thus, user can manage network more effectively. For instance, in case of SNMP it is possible to be informed traffic about certain ports but through RMON you can monitor traffics occurred in overall network, traffics of each host connected to segment, and the current status of traffic between hosts.

Since RMON processes quite lots of data, its processor share is very high. Therefore, administrator should take intensive care to prevent performance degradation and not to overload network transmission caused by RMON. There are nine RMON MIB groups defined in RFC 1757: Statistics, History, Alarm, Host, Host Top N, Matrix, Filter, Packet Capture and Event. The switch supports two MIB groups of them, most basic ones: Statistics (only for uplink ports) and History.

7.4.1 RMON History

RMON history is periodical sample inquiry of statistical data about each traffic occurred in Ethernet port. Statistical data of all ports are pre-configured to be monitored at 30-minute interval, and 50 statistical data stored in one port. It also allows you to configure the time interval to take the sample and the number of samples you want to save.

To open *RMON Configuration* mode, use the following command.

Command	Mode	Description
rmon-history <1-65535>	Global	Opens *RMON Configuration* mode. 1-65535: index number

The following is an example of opening *RMON Configuration* mode with index number 5.

```
SWITCH(config)# rmon-history 5
SWITCH(config-rmonhistory[5])#
```

Input a question mark <**?**> at the system prompt in *RMON Configuration* mode if you want to list available commands.

The following is an example of listing available commands in *RMON Configuration* mode.

```
SWITCH(config-rmonhistory[5])# ?
RMON history configuration commands:
  active               Activate the history
  data-source          Set data source name for the ethernet port
  do                   To run exec commands in config mode
  exit                 End current mode and down to previous mode
  help                 Description of the interactive help system
  interval             Define the time interval for the history
  owner                Assign the owner who define and is using the history
                       resources
  requested-buckets    Define the bucket count for the interval
  show                 Show running system information
  write                Write running configuration to memory or terminal

SWITCH(config-rmonhistory[5])#
```

7.4.1.1 Source Port of Statistical Data

To specify a source port of statistical data, use the following command.

Command	Mode	Description
data-source *NAME*	RMON	Specifies a data object ID: NAME: enters a data object ID. (ex. ifindex.n1/port1)

7.4.1.2 Subject of RMON History

To identify a subject using RMON history, use the following command.

Command	Mode	Description
owner *NAME*	RMON	Identifies subject using relevant data, enter the name (max. 32 characters).

7.4.1.3 Number of Sample Data

To configure the number of sample data of RMON history, use the following command.

Command	Mode	Description
requested-buckets <1-65535>	RMON	Defines a bucket count for the interval, enter the number of buckets. 1-65535: bucket number (default: 50)

7.4.1.4 Interval of Sample Inquiry

To configure the interval of sample inquiry in terms of second, use the following command.

Command	Mode	Description
interval <1-3600>	RMON	Defines the time interval for the history (in seconds), enter the value. (default: 1800)

i 1 sec is the minimum time which can be selected. But the minimum sampling interval currently is 30 sec, i.e., all intervals will be round up to a multiple of 30 seconds.

7.4.1.5 Activating RMON History

To activate RMON history, use the following command.

Command	Mode	Description
active	RMON	Activates RMON history.

i Before activating RMON history, check if your configuration is correct. After RMON history is activated, you cannot change its configuration. If you need to change configuration, you need to delete the RMON history and configure it again.

7.4.1.6 Deleting Configuration of RMON History

When you need to change a configuration of RMON history, you should delete an existing RMON history.

To delete an RMON history, use the following command.

Command	Mode	Description
no rmon-history <1-65535>	Global	Deletes the RMON history of specified number, enter the value for deleting.

7.4.1.7 Displaying RMON History

To display an RMON history, use the following command.

Command	Mode	Description
show running-config rmon-history	All	Shows a configured RMON history.

i Always the last values will be displayed but no more than the number of the granted buckets.

The following is an example of displaying RMON history.

```
SWITCH(config-rmonhistory[5])# show running-config rmon-history
!
rmon-history 5
 owner test
 data-source ifindex.hdlc1
 interval 60
 requested-buckets 25
 active
!
SWITCH(config-rmonhistory[5])#
```

7.4.2 RMON Alarm

You need to open *RMON Alarm Configuration* mode first to configure RMON alarm.

Command	Mode	Description
rmon-alarm <1-65535>	Global	Opens *RMON Alarm Configuration* mode. 1-65535: index number

7.4.2.1 Subject of RMON Alarm

You need to configure RMON alarm and identify subject using many kinds of data from alarm. To identify subject of alarm, use the following command.

Command	Mode	Description
owner *NAME*	RMON	Identifies subject using relevant data, enter the name (max. 32 characters).

7.4.2.2 Object of Sample Inquiry

To assign object used for sample inquiry, use the following command.

Command	Mode	Description
sample-variable *MIB-OBJECT*	RMON	Assigns MIB object used for sample inquiry.

7.4.2.3 Absolute and Delta Comparison

There are two ways to compare with the threshold: absolute comparison and delta comparison.

- **Absolute Comparison**
  Comparing sample data with the threshold at configured interval, if the data is more than the threshold or less than it, alarm is occurred
- **Delta Comparison**
  Comparing difference between current data and the latest data with the threshold, if the data is more than the threshold or less than it, alarm is occurred.

To compare object selected as sample with the threshold, use the following command.

Command	Mode	Description
sample-type absolute	RMON	Compares object with the threshold directly.

To configure delta comparison, use the following command.

Command	Mode	Description
sample-type delta	RMON	Compares difference between current data and the latest data with the threshold.

7.4.2.4 Upper Bound of Threshold

If you need to occur alarm when object used for sample inquiry is more than upper bound of threshold, you have to configure the upper bound of threshold.

To configure upper bound of threshold, use the following command.

Command	Mode	Description
rising-threshold *VALUE*	RMON	Configures upper bound of threshold. VALUE: 0-2147483647

After configuring upper bound of threshold, configure to generate RMON event when object is more than configured threshold. Use the following command.

Command	Mode	Description
rising-event <1-65535>	RMON	Configures to generate RMON event when object is more than configured threshold. 1-65535: event index

7.4.2.5 Lower Bound of Threshold

If you need to occur alarm when object used for sample inquiry is less than lower bound of threshold, you should configure lower bound of threshold. To configure lower bound of threshold, use the following command.

Command	Mode	Description
falling-threshold *VALUE*	RMON	Configures lower bound of threshold.

After configuring lower bound of threshold, configure to generate RMON event when object is less than configured threshold. Use the following command.

Command	Mode	Description
falling-event <1-65535>	RMON	Configures to generate RMON alarm when object is less than configured threshold.

7.4.2.6 Standard of the First Alarm

It is possible for users to configure standard when alarm is first occurred. User can select the first point when object is more than threshold, or the first point when object is less than threshold, or the first point when object is more than threshold or less than threshold.

To configure the first RMON alarm to occur when object is less than lower bound of threshold first, use the following command.

Command	Mode	Description
startup-type falling	RMON	Configures the first RMON Alarm to occur when object is less than lower bound of threshold first.

To configure the first alarm to occur when object is firstly more than upper bound of threshold, use the following command.

Command	Mode	Description
startup-type rising	RMON	Configures the first Alarm to occur when object is firstly more than upper bound of threshold.

To configure the first alarm to occur when object is firstly more than threshold or less than threshold, use the following command.

Command	Mode	Description
startup-type rising-and-falling	RMON	Configures the first Alarm to occur when object is firstly more than threshold or less than threshold.

7.4.2.7 Interval of Sample Inquiry

The interval of sample inquiry means time interval to compare selected sample data with upper bound of threshold or lower bound of threshold in terns of seconds.

To configure interval of sample inquiry for RMON alarm, use the following command.

Command	Mode	Description
sample-interval <0-65535>	RMON	Configures interval of sample inquiry. (unit: second)

7.4.2.8 Activating RMON Alarm

After finishing all configurations, you need to activate RMON alarm. To activate RMON alarm, use the following command.

Command	Mode	Description
active	RMON	Activates RMON alarm.

7.4.2.9 Deleting Configuration of RMON Alarm

When you need to change a configuration of RMON alarm, you should delete an existing RMON alarm.

To delete RMON alarm, use the following command.

Command	Mode	Description
no rmon-alarm <1-65535>	Global	Deletes RMON history of specified number, enter the value for deleting.

7.4.3 RMON Event

RMON event identifies all operations such as RMON alarm in the switch. You can configure event or trap message to be sent to SNMP management server when sending RMON alarm.

You need to open *RMON Event Configuration* mode to configure RMON event.

Command	Mode	Description
rmon-event <1-65535>	Global	Opens *RMON Event Configuration* mode. 1-65535: index number

7.4.3.1 Event Community

When RMON event is happened, you need to input community to transmit SNMP trap message to host. Community means a password to give message transmission right.

To configure community for trap message transmission, use the following command.

Command	Mode	Description
community *NAME*	RMON	Configures password for trap message transmission right. NAME: community name

7.4.3.2 Event Description

It is possible to describe event briefly when event is happened. However, the description will not be automatically made. Thus administrator should make the description.

To specify a description about the current RMON event, use the following command.

Command	Mode	Description
description *DESCRIPTION*	RMON	Specifies the description of the current RMON event.

7.4.3.3 Subject of RMON Event

You need to configure event and identify subject using various data from event. To identify subject of RMON event, use the following command.

Command	Mode	Description
owner *NAME*	RMON	Identifies subject of event. You can use maximum 126 characters and this subject should be same with the subject of RMON event.

7.4.3.4 Event Type

When RMON event is happened, you need to configure event type to arrange where to send event.

To configure event type, use the following command.

Command	Mode	Description
type log	RMON	Configures event type as log type. Event of log type is sent to the place where the log file is made.
type trap		Configures event type as trap type. Event of trap type is sent to SNMP administrator and PC.
type log-and-trap		Configures event type as both log type and trap type.
type none		Configures none event type.

7.4.3.5 Activating RMON Event

After finishing all configurations, you should activate RMON event. To activate RMON event, use the following command.

Command	Mode	Description
active	RMON	Activates RMON event.

7.4.3.6 Deleting Configuration of RMON Event

Before changing the configuration of RMON event, you should delete RMON event of the number and configure it again.

To delete RMON event, use the following command.

Command	Mode	Description
no rmon-event <1-65535>	Global	Delete RMON event of specified number.

7.5 Syslog

The syslog is a function that allows the network element to generate the event notification and forward it to the event message collector like a syslog server. This function is enabled as default, so even though you disable this function manually, the syslog will be enabled again.

This section contains the following contents.

- Syslog Output Level
- Facility Code
- Syslog Bind Address
- Debug Message for Remote Terminal
- Disabling Syslog
- Displaying Syslog Message
- Displaying Syslog Configuration

7.5.1 Syslog Output Level

Syslog Output Level without a Priority

To set a syslog output level, use the following command.

Command	Mode	Description
syslog output {**emerg** | **alert** | **crit** | **err** | **warning** | **notice** | **info** | **debug**} **console**	Global	Generates a syslog message of selected level or higher and forwards it to the console.
syslog output {**emerg** | **alert** | **crit** | **err** | **warning** | **notice** | **info** | **debug**} **local** {**volatile** | **non-volatile**}		Generates a syslog message of selected level or higher in the system memory. volatile: deletes a syslog message after restart. non-volatile: reserves a syslog message.
syslog output {**emerg** | **alert** | **crit** | **err** | **warning** | **notice** | **info** | **debug**} **remote** *A.B.C.D*		Generates a syslog message of selected level or higher and forwards it to a remote host.

To disable a specified syslog output, use the following command.

Command	Mode	Description
no syslog output {**emerg** | **alert** | **crit** | **err** | **warning** | **notice** | **info** | **debug**} **console**	Global	Deletes a specified syslog output.
no syslog output {**emerg** | **alert** | **crit** | **err** | **warning** | **notice** | **info** | **debug**} **local** {**volatile** | **non-volatile**}		
no syslog output {**emerg** | **alert** | **crit** | **err** | **warning** | **notice** | **info** | **debug**} **remote** *A.B.C.D*		

Syslog Output Level with a Priority

To set a user-defined syslog output level with a priority, use the following command.

Command	Mode	Description
syslog output priority {**auth** | **authpriv** | **kern** | **local0** | **local1** | **local2** | **local3** | **local4** | **local5** | **local6** | **local7** | **syslog** | **user**} {**emerg** | **alert** | **crit** | **err** | **warning** | **notice** | **info**} **console**	Global	Generates a user-defined syslog message with a priority and forwards it to the console.
syslog output priority {**auth** | **authpriv** | **kern** | **local0** | **local1** | **local2** | **local3** | **local4** | **local5** | **local6** | **local7** | **syslog** | **user**} {**emerg** | **alert** | **crit** | **err** | **warning** | **notice** | **info**} **local** {**volatile** | **non-volatile**}		Generates a user-defined syslog message with a priority in the system memory. volatile: deletes a syslog message after restart. non-volatile: reserves a syslog message.
syslog output priority {**auth** | **authpriv** | **kern** | **local0** | **local1** | **local2** | **local3** | **local4** | **local5** | **local6** | **local7** | **syslog** | **user**} {**emerg** | **alert** | **crit** | **err** | **warning** | **notice** | **info**} **remote** *A.B.C.D*		Generates a user-defined syslog message with a priority and forwards it to a remote host.

To disable a user-defined syslog output level, use the following command.

Command	Mode	Description
no syslog output priority {**auth** | **authpriv** | **kern** | **local0** | **local1** | **local2** | **local3** | **local4** | **local5** | **local6** | **local7** | **syslog** | **user**} {**emerg** | **alert** | **crit** | **err** | **warning** | **notice** | **info**} **console**	Global	Deletes a specified user-defined syslog output level with a priority.
no syslog output priority {**auth** | **authpriv** | **kern** | **local0** | **local1** | **local2** | **local3** | **local4** | **local5** | **local6** | **local7** | **syslog** | **user**} {**emerg** | **alert** | **crit** | **err** | **warning** | **notice** | **info**} **local** {**volatile** | **non-volatile**}		
no syslog output priority {**auth** | **authpriv** | **kern** | **local0** | **local1** | **local2** | **local3** | **local4** | **local5** | **local6** | **local7** | **syslog** | **user**} {**emerg** | **alert** | **crit** | **err** | **warning** | **notice** | **info**} **remote** *A.B.C.D*		

The order of priority is **emergency** > **alert** > **critical** > **error** > **warning** > **notice** > **info** > **debug**. If you set a specific level of syslog output, you will receive only a syslog message for selected level or higher. If you want receive a syslog message for all the levels, you need to set the level to **debug**.

The following is an example of configuring syslog message to send all logs higher than notice to remote host 10.1.1.1 and configuring local1.info to transmit to console.

```
SWITCH(config)# syslog output notice remote 10.1.1.1
SWITCH(config)# syslog output priority local1 info console
SWITCH(config)# show syslog
System logger on running!

info                local volatile
info                local non-volatile
notice              remote 10.1.1.1
local1.info         console
SWITCH(config)#
```

7.5.2 Facility Code

You can set a facility code of the generated syslog message to send them remote syslog server. This code make a syslog message distinguished from others, so network administrator can handle various syslog messages efficiently. Facility code is only used with syslog messages to send to remote syslog server.

To set a facility code, use the following command.

Command	Mode	Description
syslog local-code <0-7>	Global	Sets a facility code.
no syslog local-code		Deletes a specified facility code.

The following is an example of configuring priority of all syslog messages which is transmitted to remote host 10.1.1.1, as the facility code 0.

```
SWITCH(config)# syslog output err remote 10.1.1.1
SWITCH(config)# syslog local-code 0
SWITCH(config)# show syslog
System logger on running!

info                local volatile
info                local non-volatile
err                 remote 10.1.1.1
local_code          0
SWITCH(config)#
```

7.5.3 Syslog Bind Address

You can specify an IP address to attach to the syslog message for its identity. To specify the IP address to bind to a syslog message, use the following command.

Command	Mode	Description
syslog bind-address *A.B.C.D*	Global	Specifies the IP address to bind to a syslog message.
no syslog bind-address		Deletes a specified IP address.

7.5.4 Debug Message for Remote Terminal

To display a syslog debug message to a remote terminal, use the following command.

Command	Mode	Description
terminal monitor	Enable	Enables the terminal monitor function.
no terminal monitor		Disables the terminal monitor function.

7.5.5 Disabling Syslog

To disable the syslog, use the following command.

Command	Mode	Description
no syslog	Global	Disables the syslog.

The syslog is basically enabled in the system.

7.5.6 Displaying Syslog Message

To display the received syslog message in the system memory, use the following command.

Command	Mode	Description
show syslog local {**volatile** | **non-volatile**} [*NUMBER*]	Enable Global Bridge	Shows the received syslog messages. volatile: removes the syslog messages after restart. non-volatile: reserves the syslog messages. NUMBER: shows the last N syslog messages.
show syslog local {**volatile** | **non-volatile**} **reverse**		Shows the received syslog messages in the reverse order.
show syslog {**volatile** | **non-volatile**} **information**		Shows the usage of the area where the received syslog messages are stored.
clear syslog local {**volatile** | **non-volatile**}		Removes the received syslog messages.

The following is the sample output of displaying received syslog messages.

```
SWITCH# show syslog local non-volatile 25
Aug 28 03:33:24  system: Power A is Fault
Aug 28 03:33:35  system: Power A is Ok
Aug 28 03:33:39  system: Power A is Fault
Aug 28 03:36:01  system: Power A is Ok
Aug 28 03:36:02  system: Power A is Fault
Aug 28 03:43:09  system: Power A is Ok
Aug 28 03:43:10  system: Power A is Fault
Aug 28 04:09:36  system: Power A is Ok
Aug 28 04:09:37  system: Power A is Fault
Aug 28 04:10:55  system: Power A is Ok
Aug 28 04:10:55  system: Power A is Fault
Aug 28 04:11:03  system: Power A is Ok
Aug 28 04:11:03  system: Power A is Fault
Aug 28 04:16:21  system: Power A is Ok
Aug 28 04:16:21  system: Power A is Fault
Aug 28 04:16:27  system: Power A is Ok
Aug 28 04:16:34  system: Power A is Fault
Aug 28 04:19:14  system: Power A is Ok
Aug 28 04:19:15  system: Power A is Fault
Aug 28 06:14:12  system: Power A is Ok
Aug 28 06:14:13  system: Power A is Fault
Aug 28 11:52:03  login[222]: admin login  on `ttyp0' from `10.100.158.158'
Aug 28 11:54:21  proftpd[234]: localhost (10.100.158.158[10.100.158.158]) -
USER admin: Login successful.
Aug 28 11:54:23  proftpd[234]: localhost (10.100.158.158[10.100.158.158]) -
Logout successful.
Aug 28 11:54:42  proftpd[235]: localhost (10.100.158.158[10.100.158.158]) -
Logout successful.
SWITCH#
```

7.5.7 Displaying Syslog Configuration

To display the configuration of the syslog, use the following command.

Command	Mode	Description
show syslog	Enable Global Bridge	Shows the configuration of the syslog.

7.6 Quality of Service(QoS)

The switch provides a rule and QoS feature for traffic management. The rule classifies incoming traffic, and then processes the traffic according to user-defined policies. You can use the physical port, 802.1p priority (CoS), VLAN ID, DSCP, and so on to classify incoming packets.

You can configure the policy in order to change some data fields within a packet or to relay packets to a mirror monitor by a rule. QoS (Quality of Service) is one of useful functions to provide more reliable service for traffic flow control. It is very serviceable to prevent overloading and delaying or failing of sending traffic by giving priority to traffic.

QoS can give priority to specific traffic by basically offering higher priority to the traffic or lower priority to the others.

When processing traffic, the traffic is usually supposed to be processed in time-order like first in, first out. This way, not processing specific traffic first, might cause undesired traffic loss in case of traffic overloading. However, in case of overloading traffic, QoS can apply processing order to traffic by reorganizing priorities according to its importance. By favor of QoS, you can predict network performance in advance and manage bandwidth more efficiently.

The QoS provides the following benefits:

Control over network resources

Bandwidth, delay and packet loss can be effectively controlled by QoS feature. The network administrator can limit the bandwidth for non-critical applications (such as FTP file transfers), so that other applications have a greater amount of bandwidth available to them.

Effective use of resources

An effective use of network resources can support guaranteed bandwidth to a few critical applications to ensure reliable application performance. QoS ensures that the most important and critical traffic is transmitted immediately without starvation.

Customized service

QoS helps the internet service providers provide differentiated services for their customers of the network. It allocates guaranteed bandwidth to more important applications that produce real-time traffic, such as voice, video and audio.

Traffic Prioritization

As you deploly QoS, it guarantees bandwidth and reduces delay time to ensure the applications can transmit the packets properly by handling the traffic with higher priority than regular traffic.

7.6.1 How to Operate QoS

QoS operation is briefly described as below.

Incoming packets are classified by configured conditions, and then processed by metering, packet counter and rate-limiting on specific policer. After marking and remarking action, the switch transmits those classified and processed packets via a given scheduling algorithm.

Fig. 7.1 shows the simple procedure of QoS operation.

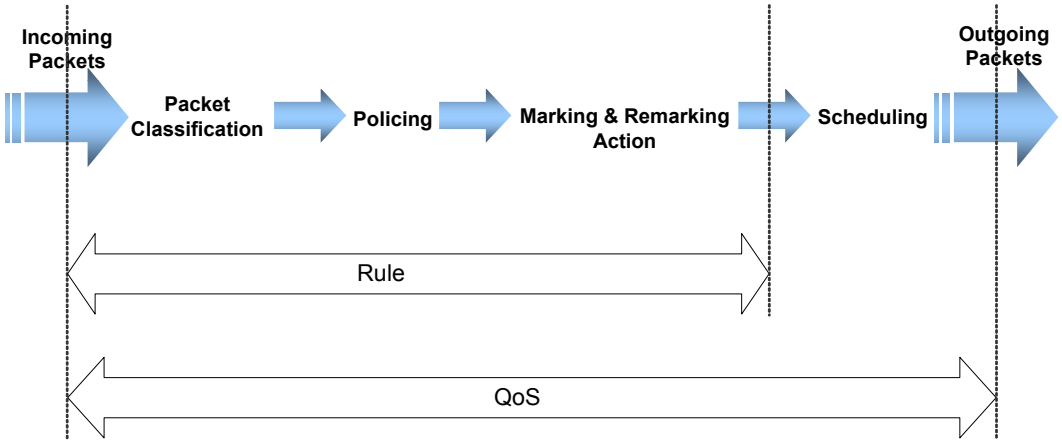


Fig. 7.1 Procedure of QoS operation

The structure of Rule has 4 types of categories with different roles for QoS.

- **Flow**
  Defines traffic classification criterias such as L3 source and destination IP address, L2 source and destination MAC address, Ethernet type, length, Class of Service (CoS), Differentiated Services Code Point (DSCP) and so on. A unique name needs to be assigned to each flow.
- **Class**
  Includes more than 2 flows for the efficient traffic management in the application of rule to this set of flows. Additionally, a unique name needs to be assigned to each class.
- **Policer**
  Defines the packet counter, coloring, rate-limit including metering function which will be applied to specified Flow and Class. The policer adjusts how and what is to be classified within transmitted packets.
  - **packet counter** calculates the classified packets for identifying a flow.
  - **rate-limit** defines which packets conform to or exceed the given rate.
  - **metering** uses to trigger real-time traffic conditioning actions.
- **Policy**
  Configures the policy classifying the action(s) to be performed if the configured rule classification fits transmitted packet(s). It cannot only include a specified Flow, Class or Policer but also set marking/remarking according to the various parameters such as CoS and DSCP which determine the rule action or priority of packets.

- **mirror** transmits the classified traffic to the monitor port.
- **redirect** transmits the classified traffic to the specified port.
- **permit** allows traffic matching given characteristics.
- **deny** blocks traffic matching given characteristics.
- **copy-to-cpu** duplicates the profile of classified packets and sends a copy to CPU
- **CoS marking** marks the incoming frame on port with CoS values.
- **CoS remarking** enables DSCP-based(L3 table) and Queue-based(L2 table) packets filtering.

- **Scheduling Algorithm**
  To handle traffic, you need to configure differently processing orders of traffic by using scheduling algorithms. The switch provides:
  - Strict Priority Queuing (SP)
  - Deficit Weighted Round Robin (DWRR).

An already applied rule can not be modified. It needs to be deleted and then created again with changed values.

Weight can be used to additionally adjust the scheduling mode per queue in DWRR mode. Weight controls the scheduling precedence of the internal packet queues.

Fig. 7.1 shows the relationship of Flow, Class, Policer and Policy on basic structure of Rule.

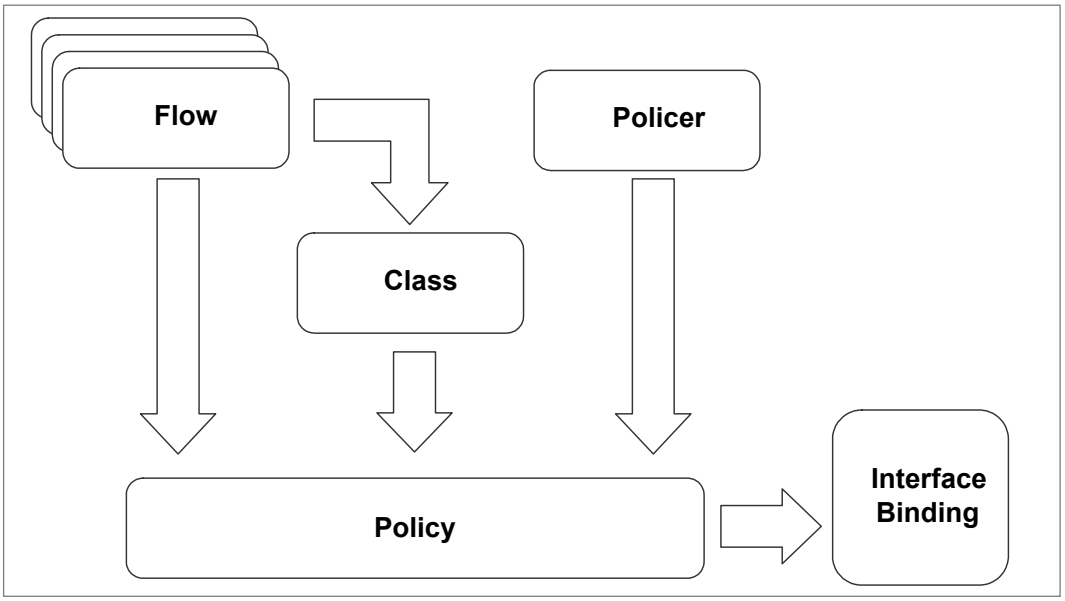


Fig. 7.2 Structure of Rule

You can simply manage more than 2 Flows through one Class. Flow or Class and Policer can be implemented by one policy.

Both Flow and Class cannot belong to one policy together. It means that one policy can include only one either Flow or Class. However, a single flow or class can belong to multiple policies. Otherwise, only one policer can belong to one policy.

The switch supports approximately 1000 rules which are actually running in the system as many as policies.

7.6.2 Packet Classification

Packet classification features allow traffic to be partitioned into multiple priority levels, or classes of service. In *Flow Configuration* mode, you can set packet classification criteria via flow, which is with unique name. If you specify the value of parameters, this switch classifies the packets corresponding to the parameters.

7.6.2.1 Flow Creation

The packet classification involves a traffic descriptor to categorize a packet within a specific flow for QoS handling in the network. You need to open *Flow Configuration* mode first to classify the packets. To open *Flow Configuration* mode, use the following command.

Command	Mode	Description
flow *NAME* **create**	Global	Creates a flow and opens *Flow Configuration* mode. NAME: flow name.

After opening *Flow Configuration* mode, the prompt changes from SWITCH(config)# to SWITCH(config-flow[NAME])#.

To delete configured Flow or all Flows, use the following command.

Command	Mode	Description
no flow *NAME*	Global	Deletes specified flow.
no flow all		Deletes all flows.

After opening *Flow Configuration* mode, a flow can be configured by user. The packet classification can be configured for each flow.

- The flow name must be unique. Its size is limited to 32 significant characters.
- The flow name cannot start with the alphabet “a” or “A”.
- The order in which the following configuration commands are entered is arbitrary.
- The configuration of a flow being configured can be changed as often as wanted until the **apply** command is entered.
- Use the **show flow-profile** command to display the configuration entered up to now.

You cannot create the flow name which started with alphabet ‘a’ If you try to make a flow name started with alphabet ‘a’, the error message will display.

7.6.2.2 Configuring Flow

The packet classification criteria needs to be defined. You can classify the packets via MAC address, IP address, Ethernet type, CoS, DSCP etc.

To specify a packet-classifying pattern with source/destination IP address or MAC address, use the following command.

Command	Mode	Description
ip {*A.B.C.D* | *A.B.C.D/M* | **any**} {*A.B.C.D* | *A.B.C.D/M* | **any**} [<0-255>]	Flow	Classifies an IP address. A.B.C.D: source/destination IP address A.B.C.D/M: source/destination IP address with mask any: any source/destination IP address 0-255: IP protocol number
ip {*A.B.C.D* | *A.B.C.D/M* | **any**} {*A.B.C.D* | *A.B.C.D/M* | **any**} **icmp**		Classifies an IP protocol (ICMP). A.B.C.D: source/destination IP address A.B.C.D/M: source/destination IP address with mask any: any source/destination IP address
ip {*A.B.C.D* | *A.B.C.D/M* | **any**} {*A.B.C.D* | *A.B.C.D/M* | **any**} **icmp** {<0-255> | **any**} {<0-255> | **any**}		Classifies an IP protocol (ICMP). A.B.C.D: source/destination IP address A.B.C.D/M: source/destination IP address with mask any: any source/destination IP address 0-255: ICMP message type number 0-255: ICMP message code number
ip {*A.B.C.D* | *A.B.C.D/M* | **any**} {*A.B.C.D* | *A.B.C.D/M* | **any**} {**tcp** | **udp**}		Classifies an IP protocol (TCP/UDP). A.B.C.D: source/destination IP address A.B.C.D/M: source/destination IP address with mask any: any source/destination IP address
ip {*A.B.C.D* | *A.B.C.D/M* | **any**} {*A.B.C.D* | *A.B.C.D/M* | **any**} {**tcp** | **udp**} {<1-65535> | **any**} {<1-65535> | **any**}		Classifies an IP protocol (TCP/UDP). A.B.C.D: source/destination IP address A.B.C.D/M: source/destination IP address with mask any: any source/destination IP address 0-65535: TCP/UDP source/destination port range any: any TCP/UDP source/destination port
ip {*A.B.C.D* | *A.B.C.D/M* | **any**} {*A.B.C.D* | *A.B.C.D/M* | **any**} **tcp** {<1-65535> | **any**} {<1-65535> | **any**} {*TCP-FLAG* | **any**}		Classifies an IP protocol (TCP). A.B.C.D: source/destination IP address A.B.C.D/M: source/destination IP address with mask any: any source/destination IP address 0-65535: TCP source/destination port range any: any TCP source/destination port TCP-FLAG: TCP flag (e.g. S(SYN), F(FIN)) any: any TCP flag
mac {*SRC-MAC-ADDR* | *SRC-MAC-ADDR/M* | **any**} {*DST-MAC-ADDR* | *DST-MAC-ADDR*/M | **any**}		Classifies MAC address. SRC-MAC-ADDR: source MAC address DST-MAC-ADDR: destination MAC address SRC/DST-MAC-ADDR/M: source/destination MAC address with mask bit any: any source/destination MAC address (ignore)
mac da-found		Classifies destination MAC addresses learned on MAC table.
mac da-not-found		Classifies destination MAC addresses not learned on MAC table.

When specifying a source and destination IP address as a packet-classifying pattern, the destination IP address must be after the source IP address.

To specify a packet-classifying pattern with various parameters (DSCP, CoS, ToS, IP precedence, packet length, Ethernet type, IP header), use the following command.

Command	Mode	Description
dscp {<0-63> | **any**}	Flow	Classifies a DSCP value. 0-63: DSCP value any: any DSCP (ignore)
cos {<0-7> | **any**}		Classifies an 802.1p priority. 0-7: 802.1p priority value any: any 802.1p priority value (ignore)
tos {<0-255> | **any**}		Classifies all ToS field. 0-255: ToS value any: any ToS value (ignore)
ip-precedence {<0-7> | **any**}		Classifies IP precedence. 0-7: IP precedence value any: any IP precedence value (ignore)
length {<21-65535> | **any**}		Classifies a packet length. (This can be used only in the extension mode!) 21-65535: IP packet length any: any IP packet length (ignore)
ethtype {*TYPE-NUM* | **arp** | **any**}		Classifies the Ethernet type. TYPE-NUM: Ethernet type field (hex, e.g. 0800 for IPv4) arp: address resolution protocol any: any Ethertype (ignore)
ip header-error		Classifies the IP header-error.
ip header-length <1-15>		Classifies the IP header-length. 1-15: IP header-length value

ip header-error command can be used only when specifying a source and destination IP address as a packet-classifying pattern.

To delete a specified packet-classifying pattern, use the following command.

Command	Mode	Description
no cos	Flow	Deletes a specified packet-classifying pattern for each option.
no dscp		
no tos		
no length		
no ip-precedence		
no ethtype		
no mac		
no mac da-found		
no mac da-not-found		
no ip		
no ip header-length		
no ip header-error		

7.6.2.3 Applying and modifying Flow

After configuring a flow using the above commands, apply it to the system with the following command. If you do not apply the flow to the system, all specified configurations on *Flow Configuration* mode will be lost.

To save and apply a flow, use the following command.

Command	Mode	Description
apply	Flow	Applies a flow to the system.

To modify a flow, use the following command.

Command	Mode	Description
flow *NAME* **modify**	Global	Modifies a flow, enter a flow name.

You should save and apply the flow to system whenever you modify or configure the flow.

7.6.2.4 Class Creation

A class is a set of flows. More than 2 flows can belong to one class. You can simply handle and configure the packets on several flows at once.

To create a class including more than 2 flows, use the following command.

Command	Mode	Description
class *NAME* **flow** *FLOW1* [*FLOW2*] [*FLOW3*]···	Global	Creates a class including more than 2 flows. NAME: class name FLOW: flow name

To delete configured class or all classes, use the following command.

Command	Mode	Description
no class all	Global	Deletes all classes.
no class *NAME*		Deletes specified class, enter the class name.
no class *NAME* **flow** *FLOW1* [*FLOW2*] [*FLOW3*]···		Removes specified flows from class.

7.6.3 Packet Conditioning

After defining traffic classification criteria in *Flow Configuration* mode, then configure how to process the packets. The classified traffic from flow or class is being treated according to the policer configuration. On *Policer Configuration* mode, a policer enforces a rate-limiting and the packet counter as well as the metering for traffic. The traffic is identified via policers, which are used to define traffic conditions including rate-limit, metering and counter. And the policy actions for the identified traffic are created with policy. One policer can belong to one policy.

7.6.3.1 Policer Creation

To configure how to handle the classified packets according to the policer settings, you need to create a policer and open *Policer Configuration* mode.

To open *Policer Configuration* mode, use the following command.

Command	Mode	Description
policer *NAME* **create**	Global	Creates a policer and opens *Policer Configuration* mode. NAME: policer name.

After opening *Policer Configuration* mode, the prompt changes from SWITCH(config)# to SWITCH(config-policer[NAME])#.

After opening *Policer Configuration* mode, a policer can be configured by user. The rate-limit, meter and packet count can be configured for each policer.

- The policer name must be unique. Its size is limited to 32 significant characters.
- The policer name cannot start with the alphabet “a” or “A”.
- The order in which the following configuration commands are entered is arbitrary.
- The configuration of a polcer being configured can be changed as often as wanted until the **apply** command is entered.
- Use the **show policer-profile** command to display the configuration entered up to now.

To delete configured policer or all policers, use the following command.

Command	Mode	Description
no policer *NAME*	Global	Deletes a policer, enter a policer name.
no policer all		Deletes all policers.

7.6.3.2 Packet Counter

The packet counter function provides information on the total number of packets that the rule received and analyzed. This feature allows you to know the type of packets transmitted in the system according to rule configuration.

To count the number of packets matching to corresponding policer, use the following command.

Command	Mode	Description
counter {**octet** | **packet**}	Policer	Counts the number of packets matching the rule in octet unit or packet unit.
no counter		Disables a packet counter function.

The switch cannot display how many packets are actually dropped by rule configuration. However, you better know the number of packets that are dropped by rule configuration even if these packets are attackable or unnecessary for the packet management. To solve this problem, switch adds the feature that transmits the dropped packets to null port and monitors them. These packets on null port are eventually eliminated from the network.

To count a number of dropped packets, use the following command.

Command	Mode	Description
action match redirect blackhole	Policer	Sends the dropped packets to Null port for the packet counter

To reset a collected policy counter, use the following command.

Command	Mode	Description
clear policy counter { *NAME* | **all**}	Enable Global Bridge	Resets a collected policy counter.

To display the number of packets on each rule, use the following command.

Command	Mode	Description
show flow statistics	Enable Global	Shows a collected flow counter.
show class statistics		Shows a collected class counter.
show policer statistics		Shows a collected policer counter.
show policy statistics		Shows a collected policy counter.

7.6.3.3 Average Packet Counter

After this switch is running on octet counter mode using **counter octet** command, you can collect and analyze the statistics of packets measured in bits per second.

To enable/disable the system to display the statistics of packets measured during current 5 seconds, 1 minute and 10 minutes in bits per second, use the following command.

Command	Mode	Description
average packet-counter octet	Policer	Enables the system to display the statistics of packets measured in bps.
no average packet-counter octet		Disables the system to display the statistics of packets measured in bps.

To display average packet-counter configuration on policy, use the following command.

Command	Mode	Description
show policy average-packet *RANGE*	Enable Global	Shows the name of policies that are enabled average packet-counter function RANGE: index of average packet counter (1-50)
show policy average-packet name *NAME*		Shows specified policy that is enabled average packet-counter function NAME: policy name
show policy average-packet		Shows the names of all policies that are enabled average packet-counter function

7.6.3.4 Rate-limit

You can configure the rate limit in kbps unit for the classified packets and control the bandwidth. To set the bandwidth of classified packets in specified policer, use the following command.

Command	Mode	Description
rate-limit *BANDWIDTH*	Policer	Sets the bandwidth for classified packets belonging to specified policer (unit: kbps)

Rate limiting is able to use a token-bucket algorithm of metering. If some traffic exceeds the rate limit because of its burst size, you can control burst capability of incoming or outgoing traffic by the token bucket size. The largest burst source can send into the network is roughly proportional to the size of the bucket. Thus, you can reduce the token bucket size manually to decrease the burst size of traffic. To configure the size of a token bucket per port or queue of port, use the following command.

Command	Mode	Description
qos max-bucketSize port { **egress** | **ingress** } *PORTS* <12-16380>	Global	Sets the size of a token bucket to specified port by its direction (unit: kbps). 12-16380: the range of token bucket size in steps of 4 (default: 16 kbps)
qos max-bucketSize port-queue *PORTS* **queue** <0-7> <12-16380>		Sets the size of a token bucket to a queue of specified port. (unit: kbps) 0-7: queue number 12-16380: the range of token bucket size in steps of 4 (default: 16 kbps)

To display configured size of a token bucket, use the following command.

Command	Mode	Description
show qos max-bucketSize port	Global	Shows the token bucket size of all ports
show qos max-bucketSize port-queue *PORTS*		Shows the token bucket size of each queue for port

7.6.3.5 Applying and modifying Policer

After configuring a policer using the above commands, apply it to the system with the following command. If you do not apply the policer to the system, all specified configurations on *Policer Configuration* mode will be lost. To save and apply a policer, use the following command.

Command	Mode	Description
apply	Policer	Applies a policer to the system.

To modify a policer, use the following command.

Command	Mode	Description
policer *NAME* **modify**	Global	Modifies a policer, enter a policer name.

7.6.4 Rule Action

7.6.4.1 Policy Creation

To configure a policy, you need to open *Policy Configuration* mode first. To open *Policy Configuration* mode, use the following command.

Command	Mode	Description
policy *NAME* **create**	Global	Creates a policy and opens *Policy Configuration* mode. NAME: policy name.

After opening *Policy Configuration* mode, the prompt changes from SWITCH(config)# to SWITCH(config-policy[NAME])#.

To delete configured policy or all policies, use the following command.

Command	Mode	Description
no policy *NAME*	Global	Deletes a policy, enter a policy name.
no policy all		Deletes all policies.

After opening *Policy Configuration* mode, a policy can be configured by user. The rule priority and rule action(s) can be configured for each policy.

- The policy name must be unique. Its size is limited to 32 significant characters.

- The policy name cannot start with the alphabet “a” or “A”.
- The order in which the following configuration commands are entered is arbitrary.
- The configuration of a policy being configured can be changed as often as wanted until the **apply** command is entered.
- Use the **show policy-profile** command to display the configuration entered up to now.

If you already create the policy, you need to include specified flow or class and policer to specify the rule action for the packets matching configured classifying patterns on flow or class and policer.

To include specific flow or class and policer in policy, use the following command.

Command	Mode	Description
include-flow *NAME*	Policy	Includes specified flow in policy. NAME:flow name
include-class *NAME*		Includes specified class in policy. NAME:class name
include-policer *NAME*		Includes specified policer in policy. NAME:policer name

One policy is not able to include both flow and class at the same time. Either flow or class can belong to one policy.

Only one policer can belong to one policy.

To remove flow or class, policer from the policy, use the following command.

Command	Mode	Description
no include-flow	Policy	Removes the flow from policy.
no include-class		Removes the class from policy.
no include-policer		Removes the policer from policy.

7.6.4.2 Metering

Meters measure the temporal state of a flow or a set of flows against a traffic profile. In this event, a meter might be used to trigger real-time traffic conditioning actions (e.g. marking, policing, or shaping).

Typical parameters of a traffic profile are:

- Committed Information Rate (CIR)
- Peak Information Rate (PIR)
- Committed Burst Size (CBS)
- Excess Burst Size (EBS)
- Peak Burst Size (PBS)

A typical meter measures the rate at which traffic stream passes it. Its rate estimation depends upon the flow state kept by the meter. There is a time constraint during which if the flow state is transferred from the old switch to the new switch, then it is effective in estimating the rate at the new switch as if though no transfer of flow has happened.

The switch provides Token Bucket (srTCM and trTCM) meters.

Token Bucket

The token bucket is a control mechanism that transmits traffic by tokens in the bucket. The tokens are consumed by transmitting traffic and regenerated at the given rate. If all tokens in the bucket are consumed out, traffic cannot be transmitted any more; a flow can transmit traffic up to its peak burst rate. The transmitting cost and regenerating rate of tokens are configurable.

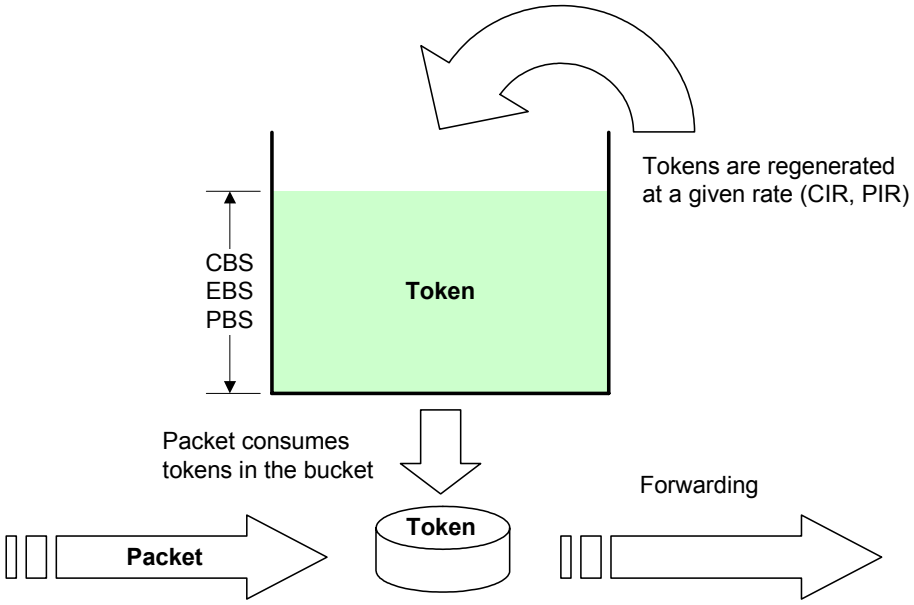


Fig. 7.3 Token Bucket Meter

Single Rate Three Color Marker (srTCM)

The srTCM meters an IP packet stream and marks its packet the one among green, yellow, and red using Committed Information Rate (CIR) and two associated burst sizes, Committed Burst Size (CBS) and Excess Burst Size (EBS). A packet is marked green if it does not exceed the CBS, yellow if it exceeds the CBS, but not the EBS, and red otherwise. The srTCM is useful for ingress policing of a service, where only the length, not the peak rate, of the burst determines service eligibility.

CIR is the regenerating rate of tokens measured in bytes of IP packets per second. CBS and EBS are the maximum size for each token bucket, C and E, measured in bytes. Both token buckets share the common rate CIR. At least one of them (CBS and EBS) must be configured, and it is recommended that the value is larger than or equal to the size of the largest possible IP packet in the stream.

The token buckets C and E are initially full. When a packet arrives, the tokens in the bucket C are decremented by the size of that packet with the green color-marking. If no

more tokens to transmit a packet remain in the bucket C, then the tokens in the bucket E are decremented by the size of that packet with the yellow color-marking. If both buckets are empty, a packet is marked red.

The following figures show the behavior of the srTCM.

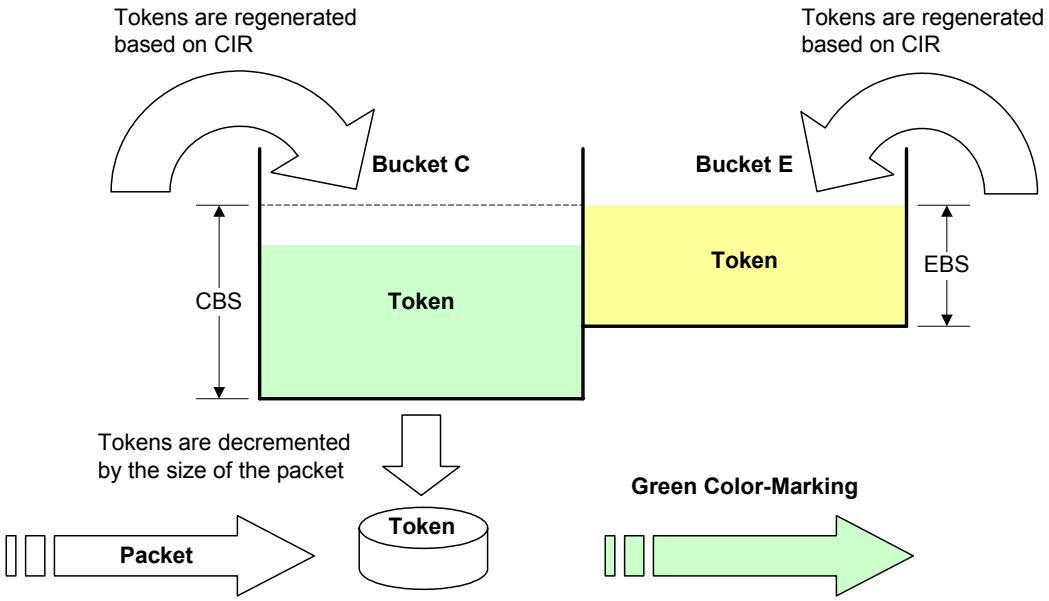


Fig. 7.4 Behavior of srTCM (1)

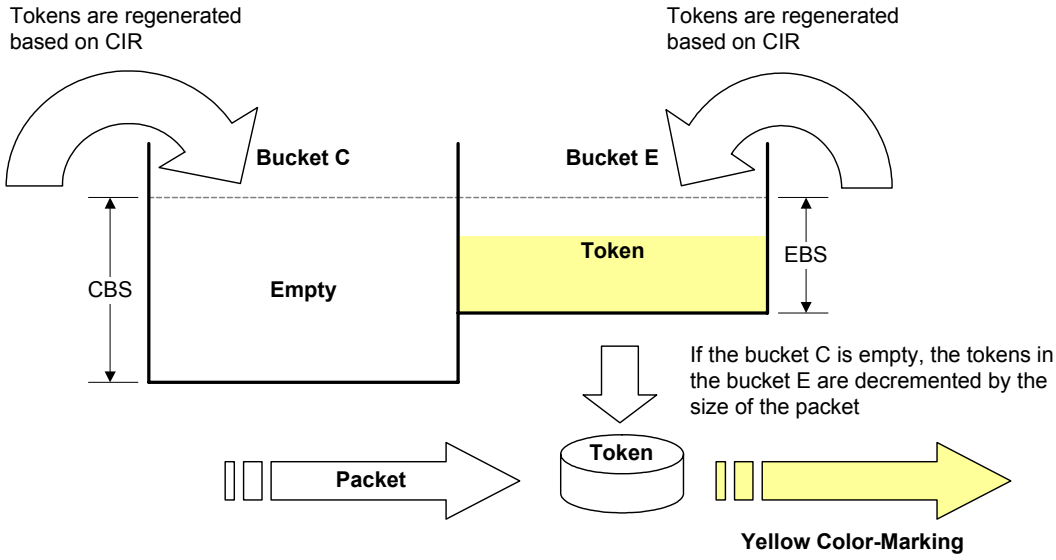


Fig. 7.5 Behavior of srTCM (2)

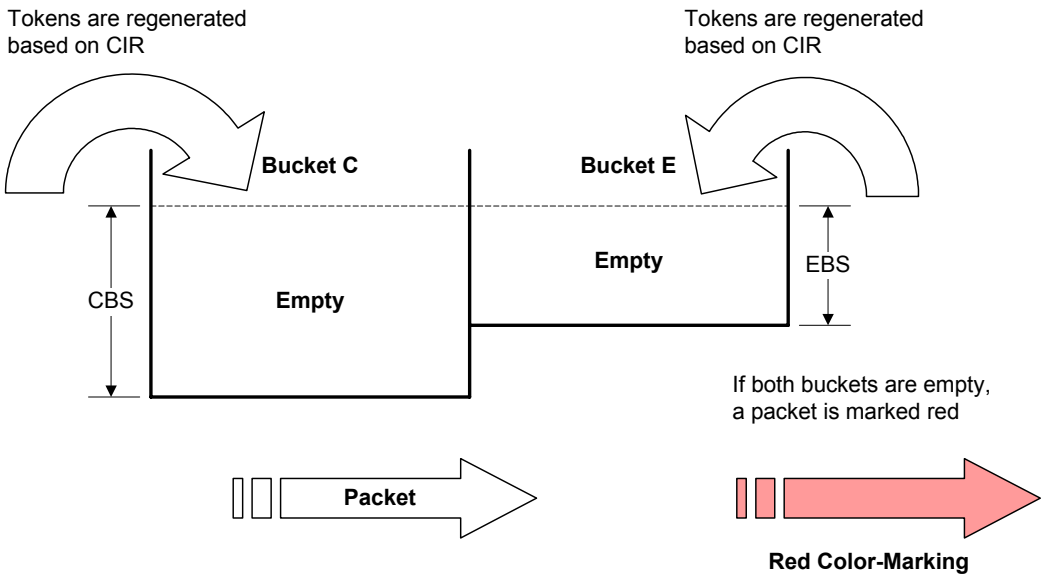


Fig. 7.6 Bahavior of srTCM (3)

Two Rate Three Color Marker (trTCM)

The trTCM meters an IP packet stream and marks its packet the one among green, yellow, and red using Peak Information Rate (PIR) and its associated Peak Burst Size (PBS) and Committed Information Rate (CIR) and its associated Committed Burst Size (CBS). A packet is marked red if it exceeds the PIR. Otherwise, it is marked either yellow or green depending on whether it exceeds or does not exceed CIR. The trTCM is useful for ingress policing of a service, where a peak rate needs to be enforced separately from a committed rate.

PIR and CIR are the regenerating rate of tokens for PBS and CBS respectively, which is measured in bytes of IP packets per second. PIR must be equal to or greater than CIR. PBS and CBS are the maximum size for each token bucket, P and C, measured in bytes. Both of them must be configured with the values equal to or greater than the size of the largest possible IP packet in the stream.

The token buckets P and C are initially full. When a packet arrives, if the tokens in the bucket P are smaller than the size of that packet, the packet is marked red. Else, if the tokens in the bucket C are smaller than the size of that packet, those are decremented by the size of that packet with the yellow color-marking. Else, if the tokens in the bucket C are larger than the size of that packet, those of both bucket P and C are decremented by the size of that packet with the green color-marking.

Note that in the trTCM algorithm, when a packet arrives, the availability of tokens in the token bucket P is checked first contrary to the srTCM; the order of color-marking is red-yellow-green.

The following figures show the behavior of the trTCM.

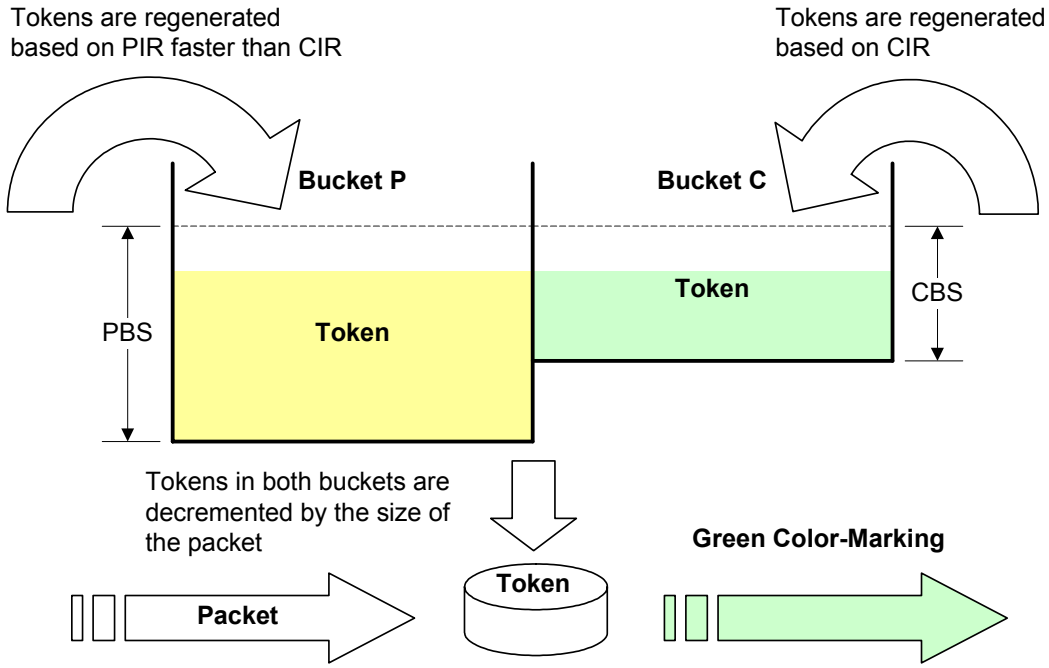


Fig. 7.7 Behavior of trTCM (1)

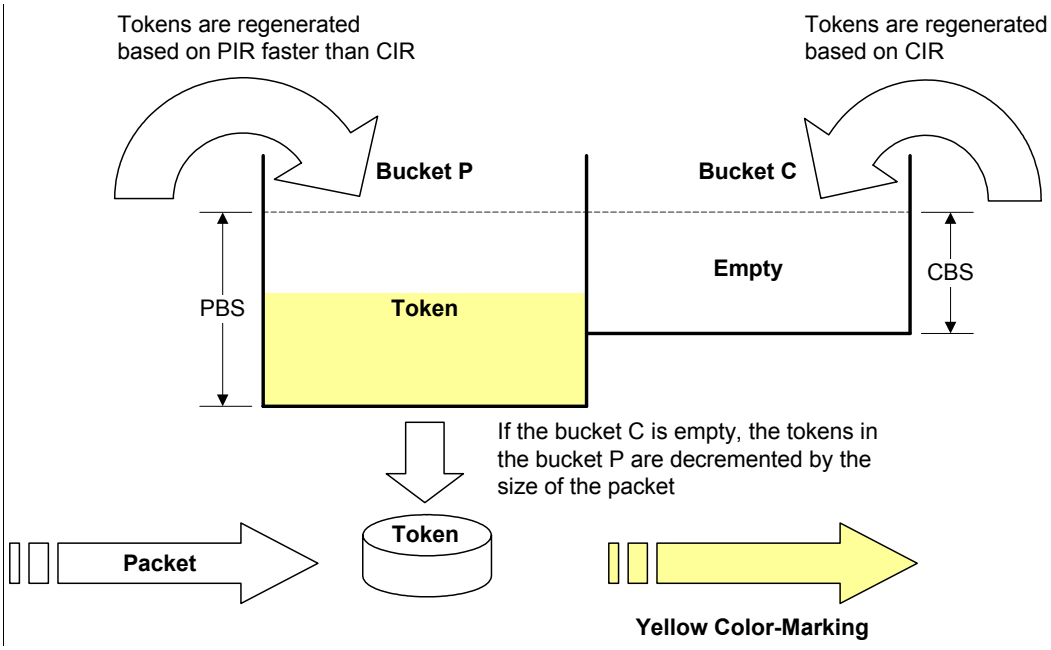


Fig. 7.8 Behavior of trTCM (2)

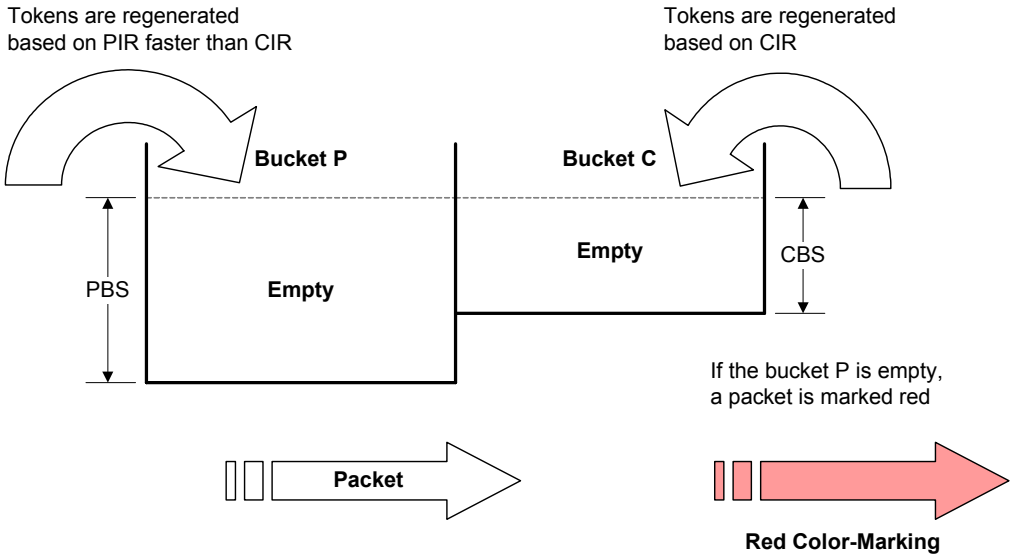


Fig. 7.9 Behavior of trTCM (3)

To set the metering mode, use the following command.

Command	Mode	Description
color mode {**srtcm** | **trtcm**} {**blind** | **aware**}	Policer	Sets the metering mode. blind: color-blind mode aware: color-aware mode
no color mode		Sets to the default setting.

i In the color-blind mode, the meter assumes that the packet stream is uncolored. In the color-aware mode the meter assumes that some preceding entity has pre-colored the incoming packet stream so that each packet is the one among green, yellow, and red.

To specify the value for metering parameters, use the following command.

Command	Mode	Description
color cir *BANDWIDTH* **cbs** *BURST*	Policer	Specifies CIR and CBS. BANDWIDTH: regenerating rate of token (unit: Kbps) BURST: maximum size of token bucket (unit: byte)
color pir *BANDWIDTH* **pbs** *BURST*		Specifies PIR and PBS. (trTCM only)
color ebs *BURST*		Specifies EBS. (srTCM only)

To configure the meter to discard all red-colored packets, use the following command.

Command	Mode	Description
color red action drop	Policer	Configures the meter to discard red-colored packets.
no color red action drop		Configures the meter to permit red-colored packets.

7.6.4.3 Policy Priority

If rules that are more than two match the same packet then the rule having a higher priority will be processed first. To set a priority for a policy, use the following command.

Command	Mode	Description
priority {**low** | **medium** | **high** | **highest**}	Policy	Sets a priority for a policy. (default: medium)

7.6.4.4 Policy Action

To specify the rule action for the packets matching configured classifying patterns, use the following command.

Command	Mode	Description
action match deny	Policy	Denies the classified packets.
action match permit		Permits the classified packets.
action match redirect vlan *VLANS* **port** *PORTS*		Redirects the classified packets to specified port. VLANS: VLAN ID (1-4094) PORTS: port number
action match mirror		Sends a copy of classified packets to mirror monitoring port.
action match vlan *VLANS*		Specifies a VLAN ID of classified packets. VLANS: VLAN ID (1-4094)
action match copy-to-cpu		Sends classified packets to CPU.
action match route next-hop *A.B.C.D*		Specifies next-hop address of classified packets. A.B.C.D:

In this switch, **redirect** command cannot be configured when MAC filtering function is running in the system.

To delete a specified rule action, use the following command.

Command	Mode	Description
no action match deny	Policy	Deletes a specified rule action.
no action match permit		
no action match redirect		
no action match mirror		
no action match vlan		
no action match copy-to-cpu		
no action match route next-hop		

7.6.4.5 Marking and Remarking

This switch can use CoS values of packet marking or remarking to support QoS feature. Packet marking allows you to partition your network into multiple priority levels or classes

of service.

Fig. 7.10 shows that 4 steps of operations can affect packet marking or remarking using the 802.1p Class of service (CoS) bits in the Ethernet header.

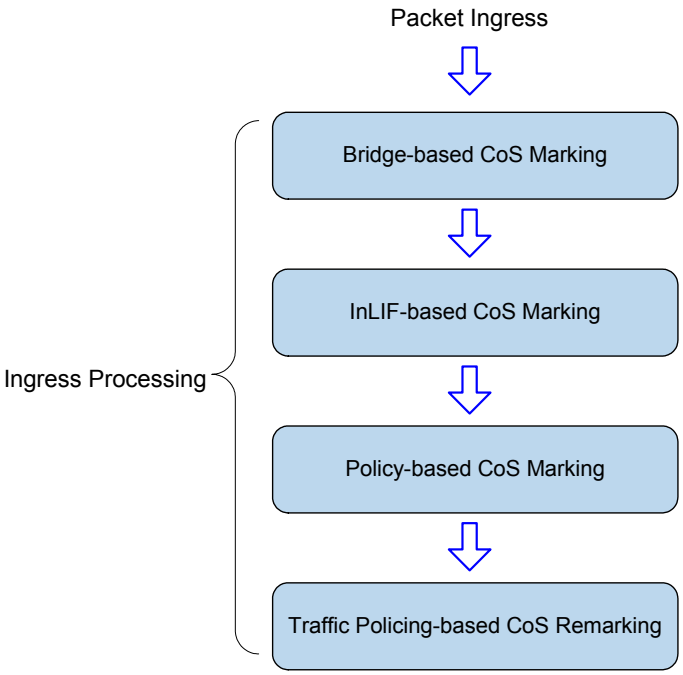


Fig. 7.10 Marking and Remarking

- **Bridge-based CoS Marking**

Generally, Bridge-based CoS Marking and InLIF-based CoS Marking are internally implemented without any additional configurations. In this switch, you can configure some parameters such as CoS, DSCP and queue for Bridge-based CoS Marking.

To configure Bridge-based CoS Marking, use the following command.

Command	Mode	Description
qos mark inbound port-cos port *PORTS* **cos** <0-7>	Bridge	Marks 802.1p class of service for incoming packets through a port, enter CoS value. port-cos: port-based user-priority marking for untagged packets 0-7: CoS value
qos mark inbound port-dscp port *PORTS* **dscp** <0-63>		Marks DSCP field on incoming packets through a port, enter DSCP value. port-dscp: port-based DSCP marking for IP packets 0-63: dscp value
qos mark inbound port-queue port *PORTS* **queue** <0-7>		Marks a queue number on incoming packets through a port. port-queue: default queue marking 0-7: queue number

Port-based user priority marking can be configured and applied to untagged packets only.

To delete Bridge-based CoS Marking, use the following command.

Command	Mode	Description
no qos mark inbound port-cos port *PORTS*	Bridge	Deletes CoS marking configuration of port.
no qos mark inbound port-dscp port *PORTS*		Deletes DSCP marking configuration of port.
no qos mark inbound port-queue port *PORTS*		Deletes Queue marking configuration of port.

To display Bridge-based CoS Marking, use the following command.

Command	Mode	Description
show qos mark inbound port-cos	Enable Global Bridge	Shows the bridge-based CoS marking configuration of specified parameter. .
show qos mark inbound port-dscp		
show qos mark inbound port-queue		

- **Policy-based CoS Marking**

To configure Policy-based CoS Marking with specified values, use the following command.

Command	Mode	Description
action match queue <0-7>	Policy	Marks the packets with queue number. 0-7: queue number
Command	**Mode**	**Description**
action match cos <0-7>	Policy	Marks the packets with 802.1p class of service. 0-7: CoS value
action match dp <0-2>		Marks the packets with drop precedence. 0-2: Drop precedence value
action match dscp <0-63>		Marks the packets with DSCP field. 0-63: DSCP value

To delete the policy-based CoS marking, use the following command.

Command	Mode	Description
no action match queue	Policy	Deletes the policy-based marking configuration on specified values.
no action match cos		
no action match dp		
no action match dscp		

- **Traffic Policing-based CoS Remarking**

Traffic Policing-based CoS Remarking uses 2 types of table, DSCP-based L3 table and Queue-cos-based L2 table. To configure Traffic Policing-based CoS Remarking, you need to select one type of table and parameter.

To select a table and enable the remarking configuration, use the following command.

Command	Mode	Description
remark by-dscp	Policer	Uses a DSCP-based L3 table.
remark by-queue		Uses a Queue-based L2 table.
remark dscp-cos		Enables the remarking configuration by external CoS.
remark queue		Enables the remarking configuration by traffic class queue.

To disable the remarking function according to its different parameter, use the following command.

Command	Mode	Description
no remark by-dscp	Policer	Disables a configured remarking function by different parameter.
no remark by-queue		
no remark dscp-cos		
no remark queue		

i In this switch, L3 table has a higher priority than L2 table in Traffic Policing-based CoS Remarking status. L2 table has a lower priority than L3 all the time, except when user does not select L3 table. It follows the configuration of L3 table when both L3 and L2 tables are selected by user.

If the remarking function is enabled in this switch, it performs according to the policy of Traffic Policing-based CoS Remarking.

To remark the colored packets with CoS parameters, use the following command.

Command	Mode	Description
qos remark color {**green** | **yellow** | **red** } **dscp** <0-63> **cos** <0-7>	Global	Remarks CoS parameters according to DSCP value and metering configuration on system. 0-63: DSCP field value 0-7: CoS value 0-2: drop precedence 0-7: queue number
qos remark color {**green** | **yellow** | **red** } **dscp** <0-63> **dp** <0-2>		
qos remark color {**green** | **yellow** | **red** } **dscp** <0-63> **dscp** <0-63>		
qos remark color {**green** | **yellow** | **red** } **dscp** <0-63> **queue** <0-7>		
qos remark color {**green** | **yellow** | **red** } **queue** <0-7> **cos** <0-7>		
qos remark color {**green** | **yellow** | **red** } **queue** <0-7> **dp** <0-2>		

qos remark color {**green** | **yellow** | **red** } **queue** <0-7> **dscp** <0-63>		Remarks CoS parameters according to queue number /CoS value and metering function configured on system. 0-7: CoS value or queue nunmber 0-2: drop precedence 0-63: DSCP field value
qos remark color {**green** | **yellow** | **red** } **queue** <0-7> **queue** <0-7>		

To delete a configured Traffic Policing-based CoS Remarking, use the following command.

Command	Mode	Description
no qos remark color {**green** | **yellow** | **red** } **dscp** [0-63]	Global	Deletes the configured Traffic Policing-based CoS Remarking.
no qos remark color {**green** | **yellow** | **red** } **dscp** <0-63> **cos**		
no qos remark color {**green** | **yellow** | **red** } **dscp** <0-63> **dp**		
no qos remark color {**green** | **yellow** | **red** } **dscp** <0-63> **dscp**		
no qos remark color {**green** | **yellow** | **red** } **dscp** <0-63> **queue**		
no qos remark color {**green** | **yellow** | **red** } **queue** [<0-7>]		
no qos remark color {**green** | **yellow** | **red** } **queue** <0-7> **cos**		
no qos remark color {**green** | **yellow** | **red** } **queue** <0-7> **dp**		
no qos remark color {**green** | **yellow** | **red** } **queue** <0-7> **dscp**		
no qos remark color {**green** | **yellow** | **red** } **queue** <0-7> **queue**		

To display the status of remarking based on different color marked packets, use the following command.

Command	Mode	Description
show qos remark color {**green** | **yellow** | **red** } **dscp**	Enable Global	Shows the configured remarking of DSCP value.
show qos remark color {**green** | **yellow** | **red** } **queue**		Shows the configured remarking of queue number.

7.6.4.6 Attaching a Policy to an interface

After you configure a rule including the packet classification, policing and rule action, you should attach a policy to an interface and to specify port or vlan in which the policy should be applied. If you do not specify an interface for rule, rule does not work properly.

To attach a policy to an interface, use the following command.

Command	Mode	Description
interface-binding port ingress {*PORTS* | **any** }	Policy	Attaches the policy to a specified ingress port or any port. PORTS: port number
interface-binding vlan { *VLANS* | **any** }		Attaches the policy to a specified vlan or any vlan. VLANS: VLAN ID (1-4094)

To detach a policy from an interface, use the following command.

Command	Mode	Description
no interface-binding port ingress [*PORTS*]	Policy	Removes an attached policy from ingress port.
no interface-binding vlan		Removes an attached policy from vlan.

7.6.4.7 Applying and Modifying Policy

After configuring a policy using the above commands, apply it to the system with the following command. If you do not apply the policy to the system, all specified configurations from *Policy Configuration* mode will be lost.

To save and apply a policy, use the following command.

Command	Mode	Description
apply	policy	Applies a policy to the system.

To modify a policy, use the following command.

Command	Mode	Description
policy *NAME* **modify**	Global	Modifies a policy, enter a policy name.

7.6.5 Displaying Rule

To show a rule profile configured by user, use the follwing command.

Command	Mode	Description
show flow-profile	Flow	Shows a profile of flow.
show policer-profile	Policer	Shows a profile of policer.
show policy-profile	Policy	Shows a profile of policy.

To dispaly a certain rule by its name or a specific rule of a certain type, use the following command.

Command	Mode	Description
show { **flow** | **class** | **policer** | **policy** } [*NAME*]	Enable Global Bridge	Shows the information relating to each rule, enter a rule name.
show { **flow** | **class** | **policer** | **policy** } **detail** [*NAME*]		
show running-config { **flow** | **policer** | **policy** }	All	Shows all configurations of each rule

7.6.6 Admin Rule

For the switch, it is possible to block a specific service connection like telnet, FTP, ICMP, etc with an admin rule function.

7.6.6.1 Creating Admin Flow for packet classification

To classify packets by a specific admin flow for the switch, you need to open *Admin-Flow Configuration* mode first. To open *Admin-Flow Configuration* mode, use the following command.

Command	Mode	Description
flow admin *NAME* **create**	Global	Creates an admin flow and opens *Admin-Flow Configuration* mode. NAME: admin-flow name.

After opening *Admin-Flow Configuration* mode, the prompt changes from SWITCH(config)# to SWITCH(config-admin-flow[NAME])#.

To delete configured admin flow or all admin flows, use the following command.

Command	Mode	Description
no flow admin *NAME*	Global	Deletes specified admin flow.
no flow admin all		Deletes all admin flows.

After opening *Admin-Flow Configuration* mode, a flow can be configured by user. The packet classification can be configured for each admin-flow.

- The admin-flow name must be unique. Its size is limited to 32 significant characters.
- The admin-flow name cannot start with the alphabet “a” or “A”.
- The order in which the following configuration commands are entered is arbitrary.
- The configuration of a flow being configured can be changed as often as wanted until the **apply** command is entered.
- Use the **show flow-profile admin** command to display the configuration entered up to now.

7.6.6.2 Configuring Admin Flow

You can classify the packets according to IP address, ICMP, TCP, UDP and IP header length.

To specify a packet-classifying pattern, use the following command.

Command	Mode	Description
ip {*A.B.C.D* | *A.B.C.D/M* | **any**} {*A.B.C.D* | *A.B.C.D/M* | **any**} [0-255]	Admin-Flow	Classifies an IP address: A.B.C.D: source/destination IP address A.B.C.D/M: source/destination IP address with mask any: any source/destination IP address 0-255: IP protocol number
ip {*A.B.C.D* | *A.B.C.D/M* | **any**} {*A.B.C.D* | *A.B.C.D/M* | **any**} **icmp**		Classifies an IP protocol (ICMP): A.B.C.D: source/destination IP address A.B.C.D/M: source/destination IP address with mask any: any source/destination IP address
ip {*A.B.C.D* | *A.B.C.D/M* | **any**} {*A.B.C.D* | *A.B.C.D/M* | **any**} **icmp** {<0-255> | **any**} {<0-255> | **any**}		Classifies an IP protocol (ICMP): A.B.C.D: source/destination IP address A.B.C.D/M: source/destination IP address with mask any: any source/destination IP address 0-255: ICMP message type number 0-255: ICMP message code number
ip {*A.B.C.D* | *A.B.C.D/M* | **any**} {*A.B.C.D* | *A.B.C.D/M* | **any**} {**tcp** | **udp**}		Classifies an IP protocol (TCP/UDP): A.B.C.D: source/destination IP address A.B.C.D/M: source/destination IP address with mask any: any source/destination IP address
ip {*A.B.C.D* | *A.B.C.D/M* | **any**} {*A.B.C.D* | *A.B.C.D/M* | **any**} {**tcp** | **udp**} {<0-65535> | **any**} {<0-65535> | **any**}		Classifies an IP protocol (TCP/UDP): A.B.C.D: source/destination IP address A.B.C.D/M: source/destination IP address with mask any: any source/destination IP address 0-65535: TCP/UDP source/destination port number any: any TCP/UDP source/destination port
ip {*A.B.C.D* | *A.B.C.D/M* | **any**} {*A.B.C.D* | *A.B.C.D/M* | **any**} **tcp** {<0-65535> | **any**} {<0-65535> | **any**} {*TCP-FLAG* | **any**}		Classifies an IP protocol (TCP): A.B.C.D: source/destination IP address A.B.C.D/M: source/destination IP address with mask any: any source/destination IP address 0-65535: TCP source/destination port number any: any TCP source/destination port TCP-FLAG: TCP flag (e.g. S(SYN), F(FIN)) any: any TCP flag
ip header-length <1-15>		Classifies an IP header length: 1-15: IP header length value

When specifying a source and destination IP address as a packet-classifying pattern, the destination IP address must be after the source IP address.

To delete a specified packet-classifying pattern, use the following command.

Command	Mode	Description
no ip	Admin-Flow	Deletes a specified packet-classifying pattern for each option.
no ip header-length		

7.6.6.3 Applying and modifying Admin Flow

After configuring an admin flow using the above commands, apply it to the system with the following command. If you do not apply it to the system, all specified configurations from *Admin-Flow Configuration* mode will be lost.

To save and apply an admin flow, use the following command.

Command	Mode	Description
apply	Admin-Flow	Applies an admin flow to the system.

To modify an admin flow, use the following command.

Command	Mode	Description
flow admin *NAME* **modify**	Global	Modifies a flow, enter an admin flow name.

i You should save and apply the admin flow to system using **apply** command whenever you modify any configuration of the admin flow.

7.6.6.4 Class Creation

One class can include several flows. You can simply handle and configure the packets on several flows at once.

To create a class including more than 2 flows, use the following command.

Command	Mode	Description
class admin *NAME* **flow** *FLOW1* [*FLOW2*] [*FLOW3*]	Global	Creates an admin class including at least 2 admin flows. NAME: admin class name FLOW: admin flow name

To delete configured admin class or all admin classes, use the following command.

Command	Mode	Description
no class admin all	Global	Deletes all admin classes.
no class admin *NAME*		Deletes specified admin class. NAME: admin class name
no class admin *NAME* **flow** *FLOW1* [*FLOW2*] [*FLOW3*]		Removes specified admin flows from class. NAME: admin class name FLOW: admin flow name

7.6.7 Admin Rule Action

7.6.7.1 Admin Policy Creation

For the switch, you need to open *Admin-Policy Configuration* mode first. To open *Policy Configuration* mode, use the following command.

Command	Mode	Description
policy admin *NAME* **create**	Global	Creates an admin policy and opens *Admin-Policy Configuration* mode. NAME: admin-policy name.

After opening *Admin Policy Configuration* mode, the prompt changes from SWITCH(config)# to SWITCH(config-admin-policy[NAME])#.

To delete configured admin policy or all admin policies, use the following command.

Command	Mode	Description
no policy admin *NAME*	Global	Deletes specified admin policy.
no policy admin all		Deletes all admin policies.

After opening *Admin-Policy Configuration* mode, an admin policy can be configured by user. You can specify the rule action for the classified packets in each admin-policy.

- The admin-policy name must be unique. Its size is limited to 32 significant characters.
- The admin- policy name cannot start with the alphabet “a” or “A”.
- The order in which the following configuration commands are entered is arbitrary.
- The configuration of an admin policy being configured can be changed as often as wanted until the **apply** command is entered.
- Use the **show policy-profile admin** command to display the configuration entered up to now.

If you create the admin policy already, you need to include specified flow or class to specify the rule action for the packets matching configured classifying patterns on flow or class.

To include specific flow or class in an admin policy, use the following command.

Command	Mode	Description
include-flow *NAME*	Admin-Policy	Includes an admin flow in a specified policy. NAME:admin-flow name
include-class *NAME*		Includes an admin class in a specified policy. NAME:admin-class name

One admin policy cannot include both flow and class at the same time. Either admin flow or admin class can belong to one policy.

To remove flow or class from the policy, use the following command.

Command	Mode	Description
no include-flow	Admin-Policy	Removes the admin flow from this policy.
no include-class		Removes the admin class from this policy.

7.6.7.2 Admin Policy Priority

If rules that are more than two match the same packet then the rule having a higher priority will be processed first.

To set a priority for an admin access rule, use the following command.

Command	Mode	Description
priority {**highest** | **high** | **medium**| **low**}	Admin-Policy	Sets a priority for an admin policy. (default: medium)

7.6.7.3 Admin Policy Action

To specify the rule action (**action match**) for the packets matching configured classifying patterns, use the following command.

Command	Mode	Description
action match deny	Admin-Policy	Denies a packet.
action match permit		Permits a packet.

To delete a specified rule action(**action match**), use the following command.

Command	Mode	Description
no action match deny	Admin-Policy	Deletes a specified rule action.
no action match permit		

To specify a rule action (**no-action match**) for the packets **not** matching configured classifying patterns, use the following command.

Command	Mode	Description
no-action match deny	Admin-Policy	Denies a packet.
no-action match permit		Permits a packet.

To delete a specified rule action(**no-action match**), use the following command.

Command	Mode	Description
no no-action match deny	Admin-Policy	Deletes a specified rule action.
no no-action match permit		

7.6.7.4 Applying and Modifying Admin Policy

After configuring an admin policy using the above commands, apply it to the system with the following command. If you do not apply this policy to the system, all specified configurations from *Admin-Policy Configuration* mode will be lost.

To save and apply an admin policy, use the following command.

Command	Mode	Description
apply	Admin-Policy	Applies an admin policy to the system.

To modify an admin policy, use the following command.

Command	Mode	Description
policy admin *NAME* **modify**	Global	Modifies an admin policy. NAME: admin-policy name.

7.6.8 Displaying Admin Rule

To show an admin rule profile configured by user, use the follwing command.

Command	Mode	Description
show flow-profile admin	Admin-Flow	Shows a profile of admin flow.
show policy-profile admin	Admin-Policy	Shows a profile of admin policy.

The following command can be used to show a certain rule by its name, all rules of a certain type, or all rules at once sorted by a rule type.

Command	Mode	Description
show { **flow** | **class** | **policy** } **admin** [*NAME*]	Enable Global Bridge	Shows the information relating to each rule, enter an admin rule name.
show { **flow** | **class** | **policy** } **admin detail** [*NAME*]		
show running-config { **admin-flow** | **admin-policy** }	All	Shows all configurations of admin rules.

7.6.9 Scheduling Algorithm

For the switch, it is possible to use Strict Priority Queuing and Deficit Weighted Round Robin for a packet scheduling mode.

The following sections explain how QoS can be configured:

- Scheduling Mode
- Weight
- Maximum and Minimum Bandwidth
- Maximum Buffer numbers
- Queue Status
- Displaying QoS
- Weighted Random Early Detection (WRED)

To process incoming packets by the queue scheduler, the switch provides the scheduling algorithm as Strict Priority Queuing (SP) and Deficit Weighted Round Robin (DWRR).

Strict Priority Queuing (SP)

SPQ processes first more important data than the others. Since all data are processed by their priority, data with high priority can be processed fast but data without low priority might be delayed and piled up. This method has a strong point of providing the distinguished service with a simple way. However, if the packets having higher priority enter, the packets having lower priority are not processed.

The processing order in Strict Priority Queuing in case of entering packets having the Queue numbers as below

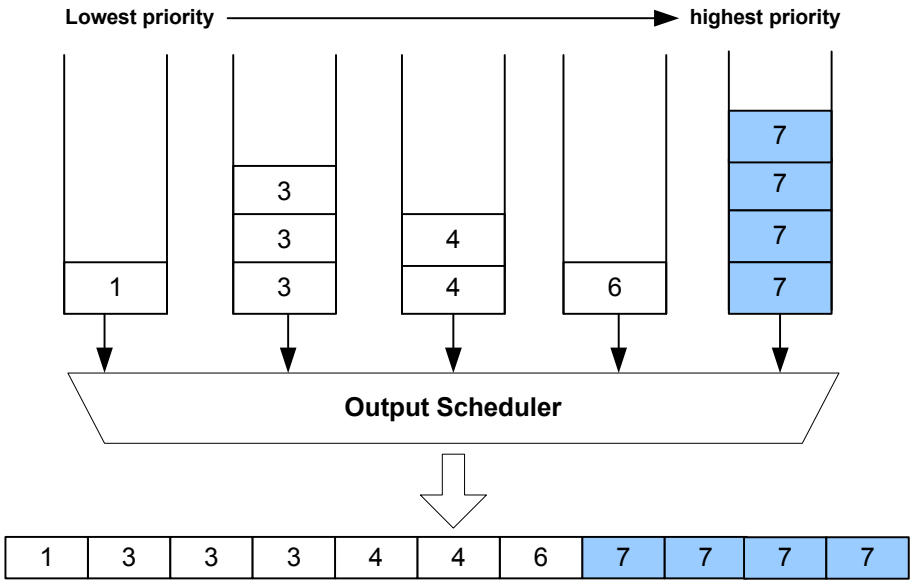


Fig. 7.11 Strict Priority Queuing

Deficit Weighted Round Robin (DWRR)

Deficit Weighted Round Robin (DWRR) combines the advantages of DRR and WRR scheduling algorithms. Processing the packets that have higher priority is the same way as strict priority queuing. DWRR provides differentiated service because it processes packets as much as weight. The specific packet length is assigned to each queue by different weight as the unit of byte. Each queue transmits different packets within packet length up to (256 bytes x configured weight) bytes in one round.

DWRR transmits from the queues without starving the low-priority queue, because each queue can be assigned with different weight. DWRR scheduling algorithm keeps the remainder of packet length from previous round and compensates for it in the next round. If a queue is not able to send a packet because its packet size is larger than the available bytes, then the unused bytes are credited to the next round.

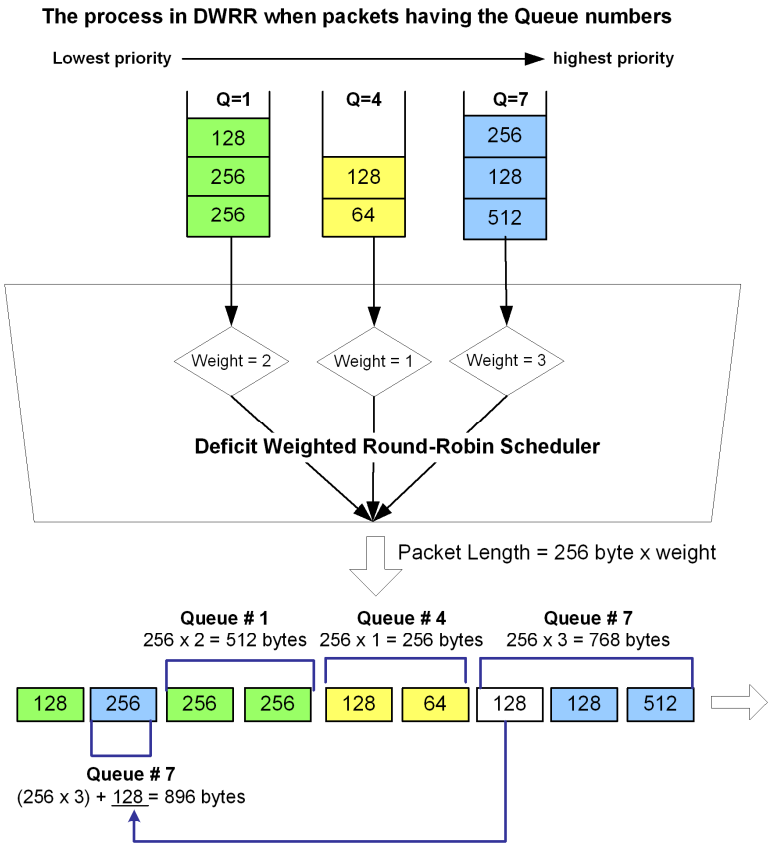


Fig. 7.12 Deficit Weighted Round Robin

Different queues have different weights, and the packet length assigned to each queue in its round is proportional to the relative weight of the queue among all the queues serviced by that scheduler.

The queue of number 7 has 3 weights, handles the packet length of 768 bytes at once in its round. If the queue of number 7 was not able to send all packets in its previous round because its last packet size was too large, the remainder of 128 bytes from is added to the packet length for the next round. Therefore, the queue of number 7 can send the packets up to 896 bytes of length in its next round.

7.6.9.1 Scheduling Mode

To select a packet scheduling mode, use the following command.

Command	Mode	Description
qos scheduling-mode sp {*PORTS* | **cpu**} [<0-7>]	Global	Selects SP packet scheduling mode for ports or CPU. sp: strict priority queuing PORTS: port numbers 0-7: queue number
qos scheduling-mode dwrr {**group0** | **group1**} {*PORTS* | **cpu**} [<0-7>]		Selects DWRR packet scheduling mode for ports or CPU. dwrr: deficit weighted round robin PORTS: port number (eg. 1,2, 1-10) 0-7: queue number

i The default scheduling mode is **DWRR**. And it is possible to assign a different scheduling mode to each port.

Additionally, switch assigns DWRR scheduling mode for a group. If you select DWRR packet scheduling mode for one port as a group, all queues of this port are treated externally and internally by DWRR. However, if you select SP packet scheduling mode for one port and make one group include several queues on DWRR packet scheduling mode, this group implements as if it is one single queue. The scheduling mode of all queues is SP, but a group including several queues operates in DWRR.

7.6.9.2 Weight

To set a weight for DWRR scheduling mode, use the following command.

Command	Mode	Description
qos weight {*PORTS* | **cpu**} <0-7> <1-255>	Global	Sets a weight for each port and queue. PORTS: port numbers 0-7: queue number 1-255: weight value (default: 6)
qos base weight *PORTS* <1-255>		Sets a ratio among all queues according to configured weight. 1-255: base weight value (default: 6)

7.6.9.3 Maximum and Minimum Bandwidth

To set a maximum bandwidth, use the following command.

Command	Mode	Description
qos max-bandwidth *PORTS* <0-7> {*BANDWIDTH* | **unlimited**}	Global	Sets a maximum bandwidth for each port and queue. PORTS: port numbers 0-7: queue number BANDWIDTH: bandwidth in the unit of MB unlimited: unlimited bandwidth (default)

To set a minimum bandwidth, use the following command.

Command	Mode	Description
qos min-bandwidth *PORTS* <0-7> {*BANDWIDTH* | **unlimited**}	Global	Sets a minimum bandwidth for each port and queue. PORTS: port numbers 0-7: queue number BANDWIDTH: bandwidth in the unit of MB (default: 0) unlimited: unlimited bandwidth

A minimum bandwidth can be set only in **DWRR** scheduling mode.

By using above command, minimum bandwidth is implemented per each queue of port. Specifically, this switch provides a minimum/maximum bandwidth guarantee to the packets which match to a flow.

To set a minimum/maximum bandwidth allocated for each flow belonging to a policer, use the following command.

Command	Mode	Description
min-bandwidth *BANDWIDTH*	Policer	Sets a minimum bandwidth for each flow. BANDWIDTH: bandwidth in the unit of kbps
min-bandwidth *BANDWIDTH* **max-bandwidth** *BANDWIDTH*		Sets a minimum/maximum bandwidth for each flow. BANDWIDTH: bandwidth in the unit of kbps

To reset a minimum and maximum bandwidth allocated for each flow, use the following command.

Command	Mode	Description
no min-max-bandwidth *BANDWIDTH*	Policer	Resets a minimum/maximum bandwidth for each flow. BANDWIDTH: bandwidth in the unit of MB

The minimum and maximum bandwidth allocations for each flow support a traffic policing. Traffic policing allows that you guarantee the minimum bandwidth of traffic to be transmitted or received on an interface. Traffic that falls within the minimum bandwidth is transmitted, whereas traffic that exceeds the maximum bandwidth is dropped by a policing mechanism.

7.6.9.4 Maximum Buffer numbers

Each queue is assigned a certain amount of buffer space to store transit data. Each queue has an upper limit on the allocated number of buffers based on the class bandwidth assignment of the queue and the number of queues configured.

To configure the number of buffers per each port or queue, use the following command.

Command	Mode	Description
qos max-queue-length port *PORTS* <16-4080>	Global	Sets the total number of buffers for a port. PORTS: port number 16-4080: total buffer numbers in increments of 16 (default: 256)
qos max-queue-length port *PORTS* **queue** <0-7> <16-4080>		Sets the number of buffers for each queue of a port. PORTS: port number 0-7: queue number

To display the total number of buffers for a port and queue, use the following command.

Command	Mode	Description
show qos max-queue-length port *PORTS*	Global	Shows the total number of buffers for a port and queue. PORTS: port number

7.6.9.5 Queue Status

To display a current queue status, use the following command.

Command	Mode	Description
show queue status { **cpu** | *PORTS*} [<0-7>]	Enable Global Bridge	Shows a current queue status. 0-7: queue number

7.6.9.6 Displaying QoS

To display the configuration of QoS, use the following command.

Command	Mode	Description
show qos	Enable Global Bridge	Shows the configuration of QoS for all ports.
show qos *PORTS*		Shows the configuration of QoS per each port.

7.6.9.7 Weighted Random Early Detection (WRED)

The switch supports Weighted Random Early Detection (WRED) which can selectively discard lower priority traffic when the interface begins to get congested and provide differentiated performance characteristics for different classes of service. It minimizes the impact of dropping high priority traffic. WRED is based on the RED algorithm.

RED, which utilizes end-to-end flow-control of TCP, is a random packet dropping function when traffic reaches the user-designated threshold even before it reaches maximum buffer size. If traffic usage reaches maximum buffer size, all packets can be dropped, which makes packet loss. Therefore, in order to prevent packet loss or unstable traffic transmission, user can restrict excessive traffic over buffer size by setting up a threshold. With RED function, packet loss is reduced and stable packet transmission can be acquired.

One of the drawbacks to implement RED function is that it randomly drops large numbers of packets, and easy to drop high priority of packets. Unlike RED, WRED is not as random when dropping packets. WRED combines the capabilities of the RED algorithm with the IP precedence feature to provide for preferential traffic handling of high-priority packets.

To utilize WRED function, start queue length value, end queue length value and drop probability are necessary. Start queue length represents the starting point of random packet dropping, and drop probability indicates the percentage of packet dropping from the starting point of random packet dropping to the point of complete dropping. If probability is large value, large amount of packets would be dropped. Therefore complete dropping point is slowly reached. On the other hand, if probability is little, little amount of packets would be dropped. Therefore complete dropping point is quickly reached. If the probability value is 1, dropping packet would be none and the value is 15, all packets would be discarded from the point of start queue length value is reached.

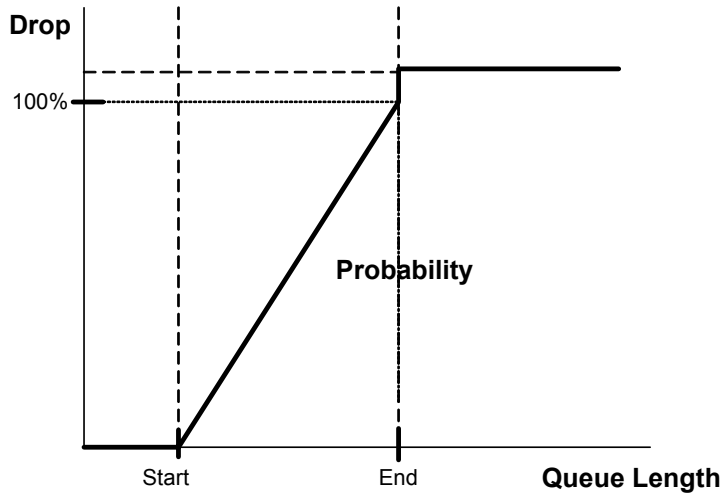


Fig. 7.13 WRED Packet Drop Probability

In creating WRED profile, you can determine how to treat different types of traffic and assign packets with certain values to specific threshold via queue numbers. Additionally, WRED profile is specified to each port.

To create and configure a WRED profile, use the following command.

Command	Mode	Description
qos wred profile <0-3> **default**	Global	Creates and configures a WRED profile with default parameters. 0-3: WRED profile number
qos wred profile <0-3> **threshold** <0-7> <0-2> **start** <1-65535> **end** <1-65535> **prob** <1-15>		Creates and configures a WRED profile with specific parameters' values. 0-3: WRED profile number 0-7: queue number 0-2: drop precedence 1-65535: start / end queue length value (unit of 256 bytes) 1-15: drop probability
qos wred profile <0-3> **weight** <0-7> <1-15>		Creates and configures a WRED profile with specific queue number and weight. 0-7: queue number 1-15: WRED queue weight (default:9)

WRED function needs to be enabled on specific port to apply WRED profile to port. To enable WRED function and apply it to a port, use the following command.

Command	Mode	Description
qos wred enable *PORTS*	Global	Enables WRED function on port. PORTS: port number
qos wred bind *PORTS* **profile** <0-3>		Applies WRED profile to ports. 0-3: WRED profile number

To disable WRED function, use the following command.

Command	Mode	Description
qos wred disable *PORTS*	Global	Disables WRED function. PORTS: port number

7.7 NetBIOS Filtering

NetBIOS (Network Basic Input/Output System) is a program that allows applications on different computers to communicate within a local area network (LAN). NetBIOS is used in Ethernet, included as part of NetBIOS Extended User Interface (NetBEUI). Resource and information in the same network can be shared with this protocol.

But the more computers are used recently, the more strong security is required. To secure individual customer's information and prevent information leakages in the LAN environmen, the switch provides NetBIOS filtering function.

Without NetBIOS filtering, customer's data may be opened to each other even though the data should be kept. To keep customer's information and prevent sharing information in the above case, NetBIOS filtering is necessary.

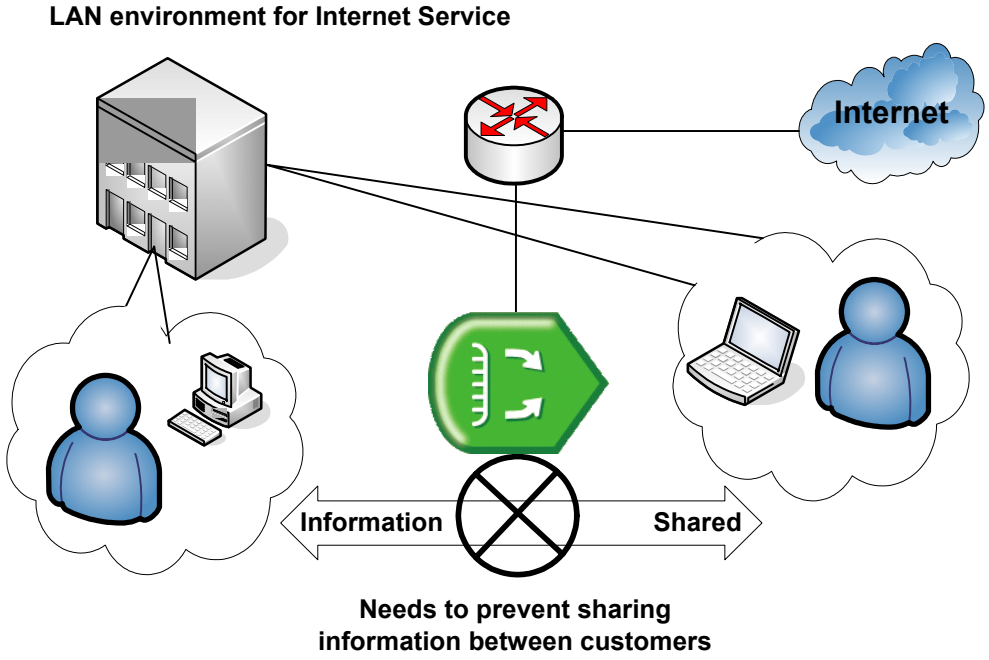


Fig. 7.14 NetBIOS Filtering

To enable/disable NetBIOS filtering, use the following command.

Command	Mode	Description
netbios-filter *PORTS*	Bridge	Configures NetBIOS filtering to a specified port.
no netbios-filter *PORTS*		Disables NetBIOS filtering from a specified port.

To display a configuration of NetBIOS filtering, use the following command.

Command	Mode	Description
show netbios-filter	Enable Global Bridge	Shows a configuration of NetBIOS filtering.

The following is an example of configuring NetBIOS filtering in port 1-2 and showing it.

```
SWITCH(bridge)# netbios-filter 1-2
SWITCH(bridge)# show netbios-filter
o:enable .:disable
----------------------------
        1        2
12345678901234567890123456789012345678
----------------------------
oo..........................
----------------------------

SWITCH(bridge)#
```

7.8 Max New Hosts

For the switch, you have to lock the port like MAC filtering before configuring max hosts. In case of ISPs, it is possible to arrange a billing plan for each user by using this configuration.

Max-new-host is to limit the number of users by configuring the number of MAC addresses that can be learned on the system and on the port for a second. The number of MAC addresses that can be learned on the system has the priority.

To configure max new hosts, use the following command.

Command	Mode	Description
max-new-hosts *PORTS VALUE*	Bridge	The number of MAC addresses that can be learned on the port for a second. VALUE: maximum MAC number <1-2147483646>
max-new-hosts system *VALUE*		The number of MAC addresses that can be learned on the system for a second. VALUE: maximum MAC number <1-2147483646>

To delete configured max new hosts, use the following command.

Command	Mode	Description
no max-new-hosts [*PORTS*]	Bridge	Deletes the number of MAC addresses that can be learned on the port.
no max-new-hosts system		Deletes the number of MAC addresses that can be learned on the system.

To display configured max new hosts, use the following command.

Command	Mode	Description
show max-new-hosts	Enable Global Bridge	Shows the configured Max-new-hosts.

If MAC that already counted disappears before passing 1 second and starts learning again, it is not counted. In case the same MAC is detected on the other port also, it is not counted again. For example, if MAC that was learned on port 1 is detected on port 2, it is supposed that MAC moved to the port 2. So, it is deleted from the port 1 and learned on the port 2 but it is not counted.

7.9 Port Security

You can use the port security feature to restrict input to an interface by limiting and identifying MAC addresses of the PCs that are allowed to access the port. When you assign secure MAC addresses to a secure port, the port does not forward packets with source addresses outside the group of defined addresses. If you limit the number of secure MAC addresses to one and assign a single secure MAC address, the PC attached to that port is assured the full bandwidth of the port.

7.9.1 Port Security on Port

Step 1
Enable port security on the port.

Command	Mode	Description
port security *PORTS*	Bridge	Enables port security on the port.

Step 2
Set the maximum number of secure MAC addresses for the port.

Command	Mode	Description
port security *PORTS* **maximum** <1-16384>	Bridge	Sets the maximum number of secure MAC addresses for the port. (default: 1)

Step 3
Set the violation mode and the action to be taken.

Command	Mode	Description
port security *PORTS* **violation** {**shutdown** | **protect** | **restrict**}	Bridge	Selects a violation mode. (default: shutdown)

When configuring port security, note that the following information about port security violation modes:

- **protect** drops packets with unknown source addresses until you remove a sufficient number of secure MAC addresses to drop below the maximum value.
- **restrict** drops packets with unknown source addresses until you remove a sufficient number of secure MAC addresses to drop below the maximum value and causes the Security Violation counter to increment.
- **shutdown** puts the interface into the error-disabled state immediately and sends an SNMP trap notification.

Step 4
Enter a secure MAC address for the port.

Command	Mode	Description
port security *PORTS* **mac-address** *MAC-ADDR* **vlan** *NAME*	Bridge	Sets a secure MAC address for the port.

To disable the configuration of port secure, use the following command.

Command	Mode	Description
no port security *PORTS*	Bridge	Disables port security on the port.
no port security *PORTS* **mac-address** [*MAC-ADDR*] [**vlan** *NAME*]		Deletes a secure MAC address for the port.
no port security *PORTS* **maximum**		Returns to the default number of secure MAC addresses. (default: 1)
no port security *PORTS* **violation**		Returns to the violation mode to the default. (default: shutdown)

7.9.2 Port Security Aging

Port security aging is to set the aging time for all secure addresses on a port. Use this feature to remove and add PCs on a secure port without manually deleting the existing secure MAC addresses while still limiting the number of secure addresses on a port.

Command	Mode	Description
port security *PORTS* **aging static**	Bridge	Enables aging for configured secure addresses.
port security *PORTS* **aging time** <1-1440>		Configures aging time in minutes for the port. All the secure addresses age out exactly after the time.
port security *PORTS* **aging type** {**absolute** | **inactivity**}		Configures aging type.

- **absolute** all the secure addresses on this port age out exactly after the time (minutes) specified lapses and are removed from the secure address list.
- **inactivity** the secure addresses on this port age out only if there is no data traffic from the secure source addresses for the specified time period.

To disable the configuration of port secure aging, use the following command.

Command	Mode	Description
no port security *PORTS* **aging static**	Bridge	Disables aging for only statistically configured secure addresses.
no port security *PORTS* **aging time**		Disables port secure aging for all secure addresses on a port.
no port security *PORTS* **aging type**		Returns to the default condition. (absolute)

7.9.3 Displaying Port Security

To display the information of the port security, use the following command.

Command	Mode	Description
show port security [*PORTS*]	Enable Global Bridge	Shows the information of the port security.

7.10 MAC Table

A dynamic MAC address is automatically registered in the MAC table, and it is removed if there is no access to/from the network element corresponding to the MAC address during the specified MAC aging time. On the other hand, a static MAC address is manually registered by user. This will not be removed regardless of the MAC aging time before removing it manually.

To manage a MAC table in the system, use the following command.

Command	Mode	Description
mac *NAME PORT MAC-ADDR*	Bridge	Specifies a static MAC address in the MAC table. NAME: bridge name PORT: port number MAC-ADDR: MAC address
mac aging-time <10-21474830>		Specifies MAC aging time: 10-21474830: aging time (default: 300)

To remove the registered dynamic MAC addresses from the MAC table, use the following command.

Command	Mode	Description
clear mac [*NAME*]	Enable Global Bridge	Clears dynamic MAC addresses. NAME: bridge name
clear mac *NAME PORT*		Clears dynamic MAC addresses. PORT: port number
clear mac *NAME PORT MAC-ADDR*		Clears dynamic MAC addresses. MAC-ADDR: MAC address

To remove the static MAC addresses manually registered by user from the MAC table, use the following command.

Command	Mode	Description
no mac	Bridge	Deletes static MAC addresses.
no mac *NAME*		Deletes static MAC addresses, enter the bridge name.
no mac *NAME PORT*		Deletes static MAC addresses. NAME: bridge name PORT: port number
no mac *NAME PORT MACADDR*		Deletes a specified static MAC address. NAME: bridge name PORT: port number MACADDR: MAC address

To display the MAC table in the switch, use the following command.

Command	Mode	Description
show mac *NAME* [*PORT*]	Enable Global Bridge	Shows switch MAC address, selection by port number (subscriber port only): NAME: bridge name PORT: port number

i There are more than a thousand of MAC addresses in MAC table. And it is difficult to find information you need at one sight. So, the system shows a certain amount of addresses displaying –**more**– on standby status. Press any key to search more. After you find the information, you can go back to the system prompt without displaying the other table by pressing <**q**>.

7.11 MAC Filtering

It is possible to forward frame to MAC address of destination. Without specific performance degradation, maximum 4096 MAC addresses can be registered.

7.11.1 Default Policy of MAC Filtering

The basic policy of filtering based on system is set to allow all packets for each port. However the basic policy can be changed for user's requests.

After configuring basic policy of filtering for all packets, use the following command on Bridge mode to show the configuration.

Command	Mode	Description
mac-filter default-policy {**deny** | **permit**} *PORTS*	Bridge	Configures basic policy of MAC Filtering in specified port.
show mac-filter default-policy	Enable Global Bridge	Shows the basic policy.

By default, basic filtering policy provided by system is configured to permit all packets in each port.

Sample Configuration

This is an example of blocking all packets in port 1 and port 3.

```
SWTICH(bridge)#  mac-filter default-policy deny 1-3
SWTICH(bridge)# show mac-filter default-policy
  -------------------------
  PORT POLICY | PORT POLICY
  ------------+------------
    1  DENY  |    2  DENY
    3  DENY  |    4 PERMIT
    5 PERMIT |    6 PERMIT
    7 PERMIT |    8 PERMIT
    9 PERMIT |   10 PERMIT
   11 PERMIT |   12 PERMIT
   13 PERMIT |   14 PERMIT
   15 PERMIT |   16 PERMIT
   17 PERMIT |   18 PERMIT
   19 PERMIT |   20 PERMIT
   21 PERMIT |   22 PERMIT
   23 PERMIT |   24 PERMIT
   25 PERMIT |   26 PERMIT
   27 PERMIT |   28 PERMIT
   29 PERMIT |   30 PERMIT
   31 PERMIT |   32 PERMIT
   33 PERMIT |
SWITCH(config)#
```

7.11.2 Adding Policy of MAC Filter

You can add the policy to block or to allow some packets of specific address after configuring the basic policy of MAC Filtering. To add this policy, use the following command in *Bridge Configuration* mode.

Command	Mode	Description
mac-filter add *MAC-ADDRESS* {**deny** | **permit**} [<1-4094>] [*PORTS*]	Bridge	Allows or blocks packet which brings a specified MAC address to specified port.

To show a configuration about MAC filter policy, use the following command.

Command	Mode	Description
show mac-filter	Enable Global Bridge	Shows MAC filter policy.

Sample Configuration

The latest policy is recorded as number 1. The following is an example of permitting MAC address 00:02:a5:74:9b:17 and 00:01:a7:70:01:d2 and showing table of filter policy.

```
SWITCH(bridge)# mac-filter add 00:02:a5:74:9b:17 permit
SWITCH(bridge)# mac-filter add 00:01:a7:70:01:d2 permit
SWITCH(bridge)# show mac-filter
=================================
 ID |        MAC       | ACTION
=================================
   1  00:01:a7:70:01:d2   PERMIT
   2  00:02:a5:74:9b:17   PERMIT
SWITCH(bridge)#
```

The following is an example of displaying one configuration.

```
SWITCH(bridge)# show mac-filter 1
=================================
 ID |        MAC       | ACTION
=================================
   1  00:01:a7:70:01:d2   PERMIT
SWITCH(bridge)#
```

7.11.3 Deleting MAC Filter Policy

To delete MAC filtering policy, use the following command.

Command	Mode	Description
mac-filter del *SOURCE-MAC-ADDRESS*	Bridge	Deletes filtering policy for specified MAC address.

To delete MAC filtering function, use the following command.

Command	Mode	Description
no mac-filter	Bridge	Deletes all MAC filtering functions.

7.11.4 Listing of MAC Filter Policy

If you need to make many MAC filtering policies at a time, it is hard to input command one by one. In this case, it is more convenient to save MAC filtering policies at “/etc/mfdb.conf” and display the list of MAC filtering policy. To view the list of MAC filtering policy at /etc/mfdb.conf, use the following command.

Command	Mode	Description
mac-filter list	Bridge	Shows the list of MAC filtering policy at /etc/mfdb.conf.

7.12 Address Resolution Protocol (ARP)

Devices connected to IP network have two addresses, LAN address and network address. LAN address is sometimes called as a data link address because it is used in Layer 2 level, but more commonly the address is known as a MAC address. A switch on Ethernet needs a 48-bit-MAC address to transmit packets. In this case, the process of finding a proper MAC address from the IP address is called an address resolution.

On the other hand, the progress of finding the proper IP address from the MAC address is called reverse address resolution. The switches and DSLAMs find their MAC addresses from the IP addresses through address resolution protocol (ARP). ARP saves these addresses in ARP table for quick search. Referring to the IP addresses in ARP table, the packets containing the IP address are transmitted to network. When configuring the ARP table, it is possible to do it only in some specific interfaces.

This chapter consists of the following sections:

- ARP Table
- ARP Alias
- ARP Inspection
- Gratuitous ARP
- Proxy-ARP

7.12.1 ARP Table

Hosts typically have an ARP table, which is a cache of IP/MAC address mappings. The ARP Table automatically maps the IP address to the MAC address of a switch. In addition to address information, the table shows the age of the entry in the table, the encapsulation method, and the switch interface (VLAN ID) where packets are forwarded.

The switch saves IP/MAC addresses mappings in ARP table for quick search. Referring to the information in ARP table, packets attached IP address is transmitted to network. When configuring ARP table, it is possible to do it only in some specific interfaces.

7.12.1.1 Registering ARP Table

The content of ARP table is automatically registered when the relation between MAC address and IP address has been found. The network administrator could use MAC address of specific IP address in Network by registering on ARP table.

To make specific IP address to be accorded with MAC address, use the following command.

Command	Mode	Description
arp *A.B.C.D MACADDR*	Global	Sets a static ARP entry, enter the IP address and the MAC address. MACADDR: MAC address.
arp *A.B.C.D MACADDR INTERFACE*		Sets a static ARP entry, enter the IP address, the MAC address and enter an interface name. INTERFACE: interface name. MACADDR: MAC address.

To delete a registered IP address and MAC address or delete all the contents of ARP table, use the following command.

Command	Mode	Description
no arp [*A.B.C.D*]	Global	Negates a command or set sets its default
no arp *A.B.C.D INTERFACE*		Negates a command or set sets its default, enter the IP address and enter the interface name.
clear arp	Enable Global Bridge	Deletes all the contents of ARP table.
clear arp *INTERFACE*		Deletes all the contents of ARP table, enter the interface name.

7.12.1.2 Displaying ARP Table

To display the ARP table registered in the system, use the following command.

Command	Mode	Description
show arp	Enable Global Bridge	Shows ARP table.
show arp *INTERFACE*		Shows ARP table for specified interface, enter the interface name (default, br2, ...).

7.12.2 ARP Alias

Although clients are joined in the same client switch, it may be impossible to communicate between them for security reasons. When you need to make them communicate each other, the switch supports ARP alias, which responses the ARP request from client net through the concentrating switch.

To register the address of client net range in ARP alias, use the following command.

Command	Mode	Description
arp alias *A.B.C.D1 A.B.C.D2* [*MACADDR*]	Global	Registers the IP address range and MAC address in ARP alias to make user's device response ARP request. MACADDR: MAC address A.B.C.D1: start IP address A.B.C.D2: end IP address
arp alias *A.B.C.D1 A.B.C.D2* **vlan** *VLANS* **gateway** *GATEWAY*		Registers the IP address range on specified VLAN and specifies default gateqay IP address. VLANS: VLAN ID (1-4094) A.B.C.D1: start IP address A.B.C.D2: end IP address GATEWAY: gateway IP address
no arp alias *A.B.C.D1 A.B.C.D2*		Deletes the registered IP address range of ARP alias.

To set the aging time of gateway address in ARP alias, use the following command.

Command	Mode	Description
arp alias aging-time <5-2147483647>	Global	Changes the aging time of registered gateway address in ARP alias. 5-2147483647: ARP alias gateway aging time (default: 300 sec)
arp alias aging-time		Deleted the configured aging time and returns to the default settings.

i Unless you input a MAC address, the MAC address of user's device will be used for ARP response.

To display a registered ARP alias, use the following command.

Command	Mode	Description
show arp alias	Enable Global Bridge	Shows a registered ARP alias.

7.12.3 ARP Inspection

ARP provides IP communication by mapping an IP address to a MAC address. However, a malicious user can attack ARP caches of systems by intercepting the traffic intended for other hosts on the subnet. For example, Host B generates a broadcast message for all hosts within the broadcast domain to obtain the MAC address associated with the IP address of Host A. If Host C responses with an IP address of Host A (or B) and a MAC address of Host C, Host A and Host B can use Host C's MAC address as the destination MAC address for traffic intended for Host A and Host B.

ARP Inspection is a security feature that validates ARP packets in a network. It discards ARP packets with invalid IP-MAC address binding.

To activate/deactivate the ARP inspection function in the system, use the following command.

Command	Mode	Description
ip arp inspection vlan *VLANS*	Global	Activates ARP inspection on a specified VLAN. VLANS: VLAN ID (1-4094)
no ip arp inspection vlan *VLANS*		Deactivates ARP inspection on a specified VLAN.

7.12.3.1 ARP Access List

You can exclude a given range of IP addresses from the ARP inspection using ARP access lists. ARP access lists are created by the **arp access-list** command on the *Global Configuration* mode. ARP access list permits or denies the ARP packets of a given range of IP addresses.

To create/delete ARP access list (ACL), use the following command.

Command	Mode	Description
arp access-list *NAME*	Global	Opens ARP ACL configuration mode and creates an ARP access list. NAME: ARP access list name
no arp access-list *NAME*		Deletes an ARP access list.

After opening *ARP Access List Configuration* mode, the prompt changes from SWITCH(config)# to SWITCH(config-arp-acl[*NAME*])#. After opening *ARP ACL Configuration* mode, a range of IP addresses can be configured to apply ARP inspection.

i By default, ARP Access List discards the ARP packets of all IP addresses and MAC addresses.

To configure the range of IP address to deny ARP packets, use the following command.

Command	Mode	Description
deny ip any mac {**any** | **host** *MACADDR*}	ARP-ACL	Discards all ARP packets of all IP addresses with all MAC addresses which have not learned before on ARP inspection table or a specific MAC address any: ignores sender IP/MAC address host: sender host MACADDR: sender MAC address
deny ip host *A.B.C.D* **mac** {**any** | **host** *MACADDR*}		Discards ARP packets from a specific host. MACADDR: MAC address
deny ip range *A.B.C.D A.B.C.D* **mac any**		Discards ARP packets of a given range of IP addresses. A.B.C.D: start/end IP address of sender
deny ip *A.B.C.D/A* **mac** {**any** | **host** *MACADDR*}		Discards ARP packets of a sender IP network addresses. A.B.C.D/A: sender IP network address

To delete the configured range of IP address for discarding ARP packets, use the following command.

Command	Mode	Description
no deny ip any mac {**any** | **host** *MACADDR*}	ARP-ACL	Deletes a configured range of IP address to discard ARP packets. any: ignores sender MAC address host: sender host MACADDR: sender MAC address A.B.C.D: start/end IP address of sender A.B.C.D/A: sender IP network address
no deny ip host *A.B.C.D* **mac** {**any** | **host** *MACADDR*}		
no deny ip range *A.B.C.D A.B.C.D* **mac any**		
no deny ip *A.B.C.D/A* **mac** {**any** | **host** *MACADDR*}		

To specify the range of IP address to forward ARP packets, use the following command.

Command	Mode	Description
permit ip any mac {**any** | **host** *MACADDR*}	ARP-ACL	Permits ARP packets of all IP addresses with all MAC addresses which have not learned before on ARP inspection table or a specific MAC address. any: ignores sender MAC address host: sender host MACADDR: sender MAC address
permit ip host *A.B.C.D* **mac** {**any** | **host** *MACADDR*}		Permits ARP packets from a specific host. MACADDR: MAC address
permit ip range *A.B.C.D A.B.C.D* **mac any**		Permits ARP packets of a given range of IP addresses. A.B.C.D: start/end IP address of sender
permit ip *A.B.C.D/A* **mac** {**any** | **host** *MACADDR*}		Permits ARP packets of a sender IP network addresses. A.B.C.D/A: sender IP network address

To delete the configured ranged of IP address to permit ARP packets, use the following command.

Command	Mode	Description
no permit ip any mac {**any** | **host** *MACADDR*}	ARP-ACL	Deletes a configured range of IP address to permit ARP packets. any: ignores sender MAC address host: sender host MACADDR: sender MAC address A.B.C.D: start/end IP address of sender A.B.C.D/A: sender IP network address
no permit ip host *A.B.C.D* **mac** {**any** | **host** *MACADDR*}		
no permit ip range *A.B.C.D A.B.C.D* **mac any**		
no permit ip *A.B.C.D/A* **mac** {**any** | **host** *MACADDR*}		

By the following command, the ARP access list also refers to a DHCP snooping binding table to permit the ARP packets for DHCP users. This reference enables the system to permit ARP packets only for the IP addresses on the DHCP snooping binding table. The ARP access list with the DHCP snooping allows IP communications to users authorized by the DHCP snooping.

To permit/discard ARP packets for the users authorized by the DHCP snooping, use the following command.

Command	Mode	Description
permit dhcp-snoop-inspection	ARP-ACL	Permits ARP packets of users authorized by the DHCP snooping.
no permit dhcp-snoop-inspection		Discards a configured ARP packets of users authorized by the DHCP snooping.

To display the configured APR access lists, use the following command.

Command	Mode	Description
show arp access-list [*NAME*]	Global	Displays existing ARP access list names.

7.12.3.2 Enabling ARP Inspection Filtering

To enable/disable the ARP inspection filtering of a certain range of IP addresses from the ARP access list, use the following command.

Command	Mode	Description
ip arp inspection filter *NAME* **vlan** *VLANS*	Global	Enables ARP inspection filtering with a configured ARP access list on specified VLAN. NAME: ARP access list name
no ip arp inspection filter *NAME* **vlan** *VLANS*		Disables ARP inspection filtering with a configured ARP access list on specified VLAN.

i ARP inspection actually runs in the system after the configured ARP access list applies to specific VLAN using the **ip arp inspection filter** command.

7.12.3.3 ARP Address Validation

The switch also provides the ARP validation feature. Regardless of a static ARP table, the ARP validation will discard ARP packets in the following cases:

- In case a sender MAC address of ARP packet does not match a source MAC address of Ethernet header.
- In case a target MAC address of ARP reply packet does not match a destination MAC address of Ethernet header.
- In case of a sender IP address of ARP packet or target IP address is 0.0.0.0 or 255.255.255.255 or one of multicast IP addresses.

To enable/disable the ARP validation, use the following command.

Command	Mode	Description
ip arp inspection validate {**src-mac** | **dst-mac** | **ip**}	Global	Enables the ARP validation with the following options. src-mac: source MAC address. dst-mac: destination MAC address. ip: source/destination IP address.
no ip arp inspection validate {**src-mac** | **dst-mac** | **ip**}		Disables the ARP validation.

i The **src-mac**, **dst-mac**, and **ip** options can be configured together.

7.12.3.4 ARP Inspection on Trust Port

The ARP inspection defines 2 trust states, trusted and untrusted. Incoming packets via trusted ports bypass the ARP inspection process, while those via untrusted ports go through the ARP inspection process. Normally, the ports connected to subscribers are configured as untrusted, while the ports connected to an upper network are configured as trusted.

To set a trust state on a port for the ARP inspection, use the following command.

Command	Mode	Description
ip arp inspection trust port *PORTS*	Global	Sets a trust state on a port as trusted PORTS: port number
no ip arp inspection trust port *PORTS*		Sets a trust state on a port as untrusted PORTS: port number

To display a configured trust port of the ARP inspection, use the following command.

Command	Mode	Description
show ip arp inspection trust [**port** *PORTS*]	Enable Global Bridge	Shows a configured trust port of the ARP inspection.

7.12.3.5 ARP Inspection Log-buffer

Log-buffer function shows the list of subscribers who have been used invalid fixed IP addresses. This function saves the information of users who are discarded by ARP inspection and generates periodic syslog messages.

Log-buffer function is automatically enabled with ARP inspection. If this switch receives invalid or denied ARP packets by ARP inspection, it creates the table of entries that include the information of port number, VLAN ID, source IP address, source MAC address and time. In addition, you can specify the maximum number of entries.

After one of entries is displayed as a syslog message, it is removed in the order in which the entries appear in the list.

To configure the options of log-buffer function, use the following command.

Command	Mode	Description
ip arp inspection log-buffer entries <0-1024>	Global	Specifies the number of entries in log-buffer. 0-1024: the max. number of entries (default: 32)
ip arp inspection log-buffer logs <0-1024> **interval** <0-86400>		Sets the interval for displaying syslog messages of entries. 0-1024: the number of syslog messages per specified interval (default: 5) 0-86400: interval value in second (default: 1 sec)

To delete the configured options of log-buffer function, use the following command.

Command	Mode	Description
no ip arp inspection log-buffer {**entries** | **logs**}	Global	Deletes the configured options of log-buffer function.

To display the configured log-buffer function and entries' information, use the following command.

Command	Mode	Description
show ip arp inspection log	Enable Global Bridge	Displays the configured log-buffer function.

To clear all of collected entries in the list, use the following command.

Command	Mode	Description
clear ip arp inspection log	Enable Global Bridge	Clears all of collected entires in the log-buffer list.

7.12.3.6 Displaying ARP Inspection

To display a status of the ARP inspection, use the following command.

Command	Mode	Description
show ip arp inspection [**vlan** *VLANS*]	Enable Global Bridge	Shows a status of the ARP inspection.
show ip arp inspection statistics [**vlan** *VLANS*]		Shows collected statistics of the ARP inspection.

To clear collected statistics of the ARP inspection, use the following command.

Command	Mode	Description
clear ip arp inspection statistics [**vlan** *VLANS*]	Enable Global Bridge	Clears collected statistics of the ARP inspection.

7.12.4 Gratuitous ARP

Gratuitous ARP is a broadcast packet like an ARP request. It containing IP address and MAC address of gateway, and the network is accessible even though IP addresses of specific host's gateway are repeatedly assigned to the other.

Configure Gratuitous ARP interval and transmission count using following commands. And configure transmission delivery-start in order to transmit Gratuitous ARP after ARP reply.

Gratuitous ARP is transmitted after some time from transmitting ARP reply.

Command	Mode	Description
arp patrol *TIME COUNT* [*TIME*]	Global	Configures a gratuitous ARP. TIME: transmit interval COUNT: transmit count
no arp patrol		Disables a gratuitous ARP.

The following is an example of configuring the transmission interval as 10 sec and transmission times as 4 and showing it.

```
SWITCH(config)# arp patrol 10 4
SWITCH(config)# show running-config
Building configuration...
Current configuration:
hostname SWITCH

(Omitted)

arp patrol 10 4
!
no snmp
!
SWITCH(config)#
```

7.12.5 Proxy-ARP

The switch supports Proxy Address Resolution Protocol. Proxy ARP is the technique in which one host, usually a router, answers ARP requests intended for another machine. By “faking” its identity, the router accepts responsibility for routing packets to the “real” destination. Proxy ARP can help the switches on a subnet reach remote subnets without configuring routing or a default gateway.

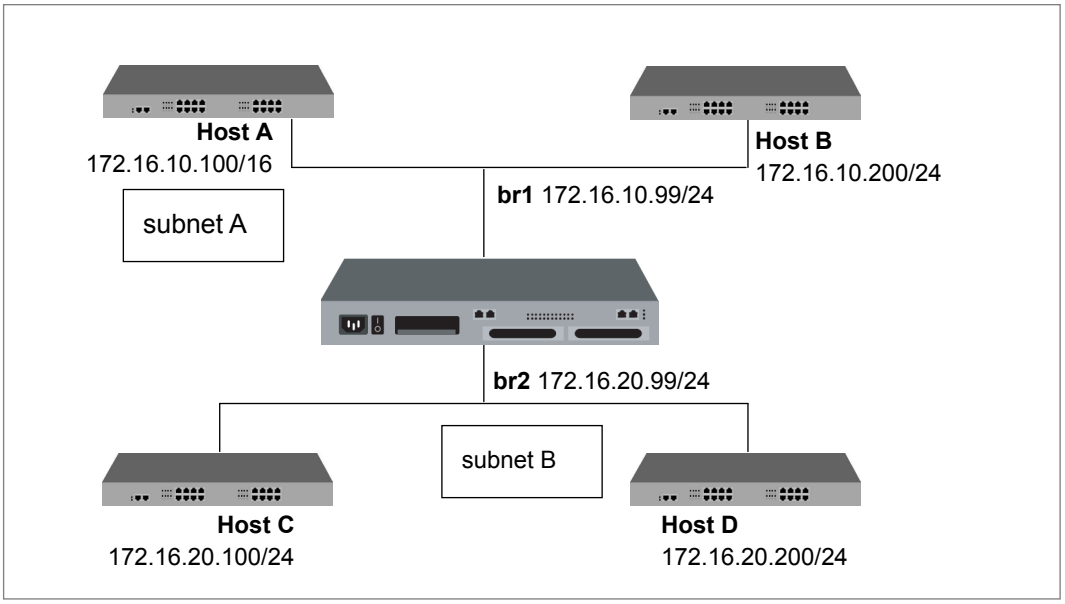


Fig. 7.15 Proxy-ARP

As shown in the diagram above, Host A has a /16 subnet mask. What this means is that Host A believes that it is directly connected to all of network 172.16.0.0. When Host A needs to communicate with any switches if believes are directly connected, it will send an ARP request to the destination. Therefore, when Host A needs to send a packet to Host D, Host A believes that Host D is directly connected, so it sends an ARP request to Host D.

Host A needs the MAC address of Host D to reach Host D. Therefore, Host A broadcasts an ARP request on Subnet A, including the switch’s Br1 interface, but does not reah Host D. This switch does not forward broadcasts by default. Since the switch knows that the target address (Host D’s IP address) is on another subnet and can reach Host D, it will reply with its own MAC address to Host A.

The Proxy ARP reply that switch sends to Host A. The proxy ARP reply packet is encapsulated in an Ethernet frame with its MAC address as the source address and Host A’s MAC address as the destination address. The ARP replies are always unicast to the original requester. On receiving this ARP reply, Host A updates its ARP table.

From now on Host A will forward all the packets that it wants to reach Host D to the MAC address of switch. Since the switch knows how to reach Host D, the router forwards the packet to Host D. The ARP cache on the hosts in Subnet A is populated with the MAC address of the switch for all the hosts on Subnet B. Hence, all packets destined to Subnet B are sent to the router. The switch forwards those packets to the hosts in Subnet B.

To enable or disable Proxy-ARP on *Interface configuration* mode, use the following command.

Command	Mode	Description
ip proxy-arp	Interface	Enables proxy-ARP at specified interface
no ip proxy-arp		Disables the configured proxy-ARP from the interface.

7.13 ICMP Message Control

ICMP stands for Internet Control Message Protocol. When it is impossible to transmit data or configure route for data, ICMP sends error message about it to host. The first 4 bytes of all ICMP messages are same, but the other parts are different ac-cording to type field value and code field value. There are fifteen values of field to distinguish each different ICMP message, and code field value helps to distinguish each type in detail.

The following table shows explanation for fifteen values of ICMP message type.

Type	Value	Type	Value
ICMP_ECHOREPLY	0	ICMP_DEST_UNREACH	3
ICMP_SOURCE_QUENCH	4	ICMP_REDIRECT	5
ICMP_ECHO	8	ICMP_TIME_EXCEEDED	11
ICMP_PARAMETERPROB	12	ICMP_TIMESTAMP	13
ICMP_TIMESTAMPREPLY	14	ICMP_INFO_REQUEST	15
ICMP_INFO_REPLY	16	ICMP_ADDRESS	17
ICMP_ADDRESSREPLY	18		

Tab. 7.1 ICMP Message Type

The following figure shows simple ICMP message structure.

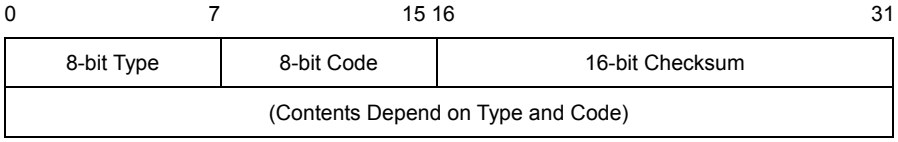


Fig. 7.16 ICMP Message Structure

It is possible to control ICMP message through user's configuration. You can configure to block the echo reply message to the partner who is doing ping test to device and interval to transmit ICMP message.

7.13.1 Blocking Echo Reply Message

It is possible to configure block echo reply message to the partner who is doing ping test to switch. To block echo reply message, use the following command.

Command	Mode	Description
ip icmp ignore echo all	Global	Blocks echo reply message to all partners who are taking ping test to device.
ip icmp ignore echo broadcast		Blocks echo reply message to partner who is taking broadcast ping test to device.

To release the blocked echo reply message, use the following command.

Command	Mode	Description
no ip icmp ignore echo all	Global	Releases blocked echo reply message to all partners who are taking ping test to device.
no ip icmp ignore echo broadcast		Releases blocked echo reply message to partner who is taking broadcast ping test to device.

7.13.2 Interval for Transmit ICMP Message

User can configure the interval for transmit ICMP message. After you configure the interval, ICMP message will be blocked until the configured time based on the last message is up. For example, if you configure the interval as 1 second, ICMP will not be sent within 1 second after the last message has been sent.

To configure interval to transmit ICMP message, the administrator should configure the type of message and the interval time.

Use the following command, to configure the interval for transmit ICMP message.

Command	Mode	Description
ip icmp interval rate-mask *MASK*	Global	Configures the interval for transmit ICMP message. MASK: user should input hexadecimal value until 0xFFFFFFFF. The default is 0x1818.

If mask that is input as hexadecimal number is calculated as binary number “1” means “Status ON”, “0” means “Status OFF”. In binary number, if the digit showed as “1” matches with the value of ICMP message. It means ICMP Message is selected as “Status ON”. Digit value starts from 0.

For example, if hexadecimal number “8” is changed as binary number, it is “1000”. In 1000, 0 digit is “0” and 1 digit is “0”, 2 digit is “0” and 3 digit is “1”. The digit showed as “1” is “3” and ICMP_DEST_UNREACH means ICMP value is “3”. Therefore, ICMP_DEST_UNREACH is chosen the message of limiting the transmission time.

Default is 0x1818. If 1818 as hexadecimal number is changed as binary number, it is 1100000011000. By calculating from 0 digit, 3 digit, 4 digit, 11 digit, 12 digit is “1” and it is “STATUS ON”. Therefore, the message that corresponds to 3, 4, 11, and 12 is chosen as the message limiting the transmission rate.

Tab. 7.2 shows the result of mask calculation of default value.

Type	Status
ICMP_ECHOREPLY (0)	OFF
ICMP_DEST_UNREACH (3)	ON
ICMP_SOURCE_QUENCH (4)	ON
ICMP_REDIRECT (5)	OFF
ICMP_ECHO (8)	OFF
ICMP_TIME_EXCEEDED (11)	ON
ICMP_PARAMETERPROB (12)	ON
ICMP_TIMESTAMP (13)	OFF
ICMP_TIMESTAMPREPLY (14)	OFF
ICMP_INFO_REQUEST (15)	OFF
ICMP_INFO_REPLY (16)	OFF
ICMP_ADDRESS (17)	OFF
ICMP_ADDRESSREPLY (18)	OFF

Tab. 7.2 Mask Calculation of Default Value

To configure the limited ICMP transmission time, use the following command.

Command	Mode	Description
ip icmp interval rate-limit *INTERVAL*	Global	Configures a limited ICMP transmission time. INTERVAL: 0-2000000000 (unit: 10 ms)

The default ICMP interval is 1 second (100 ms).

To return to default ICMP configuration, use the following command.

Command	Mode	Description
ip icmp interval default	Global	Returns to default configuration.

To display ICMP interval configuration, use the following command.

Command	Mode	Description
show ip icmp interval	Enable Global Bridge	Shows ICMP interval configuration.

7.14 TCP Flag Control

TCP (Transmission Control Protocol) header includes six kinds of flags that are URG, ACK, PSH, RST, SYN, and FIN. For the switch, you can configure RST and SYN as the below.

7.14.1 RST Configuration

RST sends a message when TCP connection cannot be done to a person who tries to make it. However, it is also possible to configure to block the message. This function will help prevent that hackers can find impossible connections.

To configure not to send the message that informs TCP connection cannot be done, use the following command.

Command	Mode	Description
ip tcp ignore rst-unknown	Global	Configures to block the message that informs TCP connection cannot be done.
no ip tcp ignore rst-unknown		Disables the unknown RST ignoring.

7.14.2 SYN Configuration

SYN sets up TCP connection. The switch transmits cookies with SYN to a person who tries to make TCP connection. And only when transmitted cookies are returned, it is possible to permit TCP connection. This function prevents connection overcrowding because of accessed users who are not using and helps the other users use service.

To permit connection only when transmitted cookies are returned after sending cookies with SYN, use the following command.

Command	Mode	Description
ip tcp syncookies	Global	Permits only when transmitted cookies are returned after sending cookies with SYN.
no ip tcp syncookies		Disables configuration to permit only when transmitted cookies are returned after sending cookies with SYN.

7.15 Packet Dump

Failures in network can be occurred by certain symptom. Each symptom can be traced to one or more problems by using specific troubleshooting tools. The switch switch provides the debug command to dump packet. Use debug commands only for problem isolation. Do not use it to monitor normal network operation. The debug commands produce a large amount of processor overhead.

7.15.1 Packet Dump by Protocol

You can see packets about BOOTPS, DHCP, ARP and ICMP using the following command.

Command	Mode	Description
debug packet {**interface** *INTERFACE* | **port** *PORTS*} **protocol** {**bootps** | **dhcp** | **arp** | **icmp**} {**src-ip** *A.B.C.D* | **dest-ip** *A.B.C.D*}	Enable	Shows packet dump by protocol.
debug packet {**interface** *INTERFACE* | **port** *PORTS*} **host** {**src-ip** *A.B.C.D* | **dest-ip** *A.B.C.D*} {**src-port** <1-65535> | **dest-port** <1-65535>}		Shows host packet dump.
debug packet {**interface** *INTERFACE* | **port** *PORTS*} **host** {**src-port** <1-65535> | **dest-port** <1-65535>}		Shows host packet dump.
debug packet {**interface** *INTERFACE* | **port** *PORTS*} **multicast** [**src-ip** *A.B.C.D* | **dest-ip** *A.B.C.D*]		Shows multicast packet dump.

7.15.2 Packet Dump with Option

You can verify packets with tcpdump options using the following command.

Command	Mode	Description
debug packet *OPTION*	Enable	Shows packet dump using options.

Tab. 7.3 shows the options for packet dump.

Option	Description
-a	Change Network & Broadcast address to name.
-d	Change the complied packet-matching code to readable letters and close it
-e	Output link-level header of each line
-f	Output outer internet address as symbol
-l	Buffer output data in line. This is useful when other application tries to receive data from tcpdump.
-n	Do not translate all address (e.g. port, host address)
-N	When output host name, do not print domain.
-O	Do not run packet-matching code optimizer. This option is used to find bug in optimizer
-p	Interface is not remained in promiscuous mode
-q	Reduce output quantity of protocol information. Therefore, output line is shorter.
-S	Output TCP sequence number not relative but absolute
-t	Time is not displayed on each output line
-v	Display more information

Tab. 7.3 Options for Packet Dump

Option	Description
-w	Save the captured packets in a file instead of output
-x	Display each packet as hex code
-c *NUMBER*	Close the debug after receive packets as many as the number
-F *FILE*	Receive file as filter expression. All additional expressions on command line are ignored.
-i *INTERFACE*	Designate the interface where the intended packets are transmitted. If not designated, it automatically select a interface which has the lowest number within the system interfaces (Loopback is excepted)
-r FILE	Read packets from the file which created by '-w' option.
-s *SNAPLEN*	This is used to configure sample packet except the 68 byte default value. The 68 byte is appropriate value for IP, ICMP, TCP and UDP, but it can truncate protocol information of Name server or NFS packets. If sample size is long, the system should take more time to inspect and packets can be dropped for small buffer size. On the contrary, if the sample size is small, information can be leaked as the amount. Therefore, user should adjust the size as header size of protocol.
-T TYPE	Display the selected packets by conditional expression as the intended type. rpc (Remote Procedure Call) rtp (Real-time Transport Protocol) rtcp (Real-time Transport Control Protocol) vat (Visual Audio Tool) wb (distributed White Board)
EXPRESSION	Conditional expression

Tab. 7.3 Options for Packet Dump (Cont.)

7.15.3 Debug Packet Dump

The switch provides network debugging function to prevent system overhead for unknown packet inflow. Monitoring process checks CPU load per 5 seconds. If there is more traffic than threshold, user can capture packets using tcpdump and save it to file. You can download the dump file with the name of file-number.dump after FTP connection to the system. See the dumped packet contents with a packet analyze program.

To debug packet dump, use the following command.

Command	Mode	Description
debug packet log *COUNT VALUE TIME* [<1-10>]	Enable	Shows dump file according to a condition. COUNT: packet counting VALUE: CPU threshold 1-10: file number

Basically you can save a current configuration with the **write memory** command. But the dump file will not be saved.

7.16 sFlow Monitoring

sFlow is a kind of monitoring functions using sFlow packet sampling algorithm. It analyzes the traffic characteristics of network packet flow from end to end. It also monitors the router and switch by collecting MIB information of interface.

Fig. 7.17 shows sFlow structure.

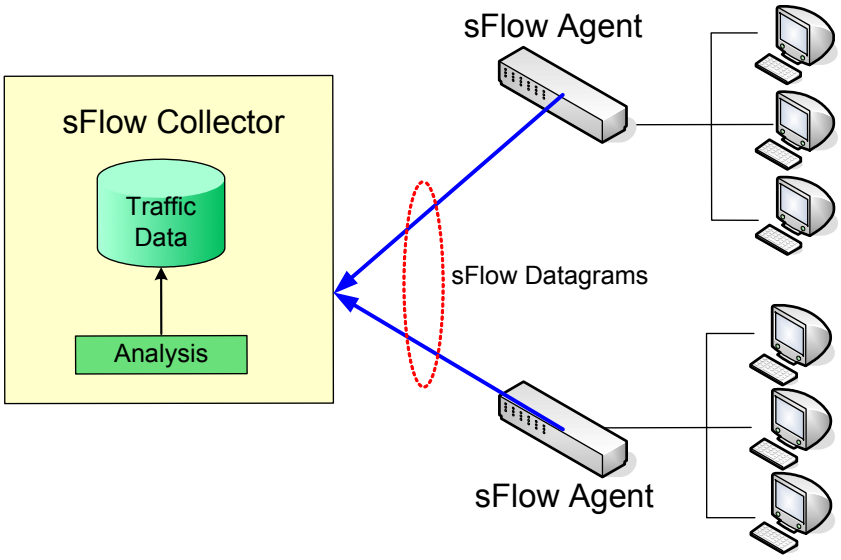


Fig. 7.17 sFlow Structure

sFlow consists of sFlow collector and sFlow agent. sFlow collector analyzes the packet transmission and sFlow agent collects packets in flow/interface statistics and sends them to sFlow collector.

The following diagram illustrates how the object instances of Agent, Sampler, Poller and Receiver are linked together in memory when the agent is running.

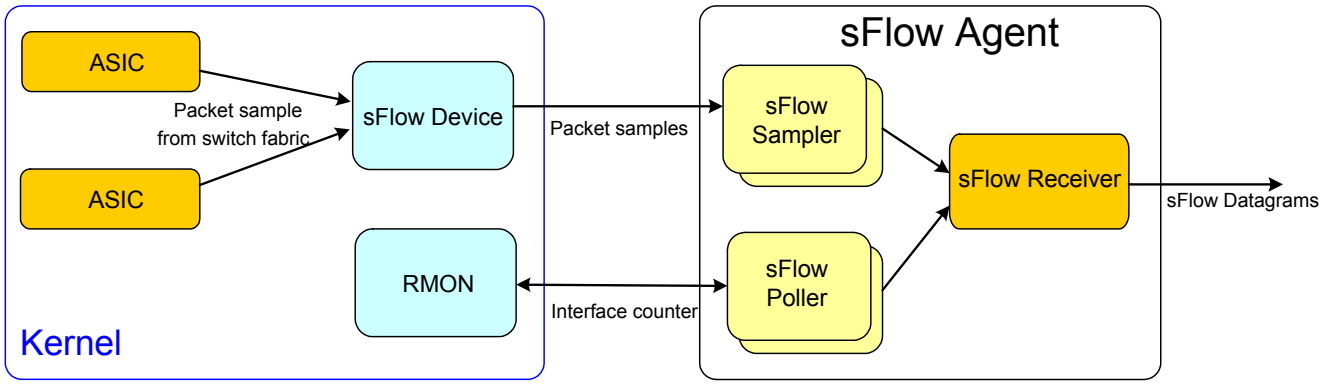


Fig. 7.18 sFlow Agent Diagram

Each interface or module inside the switch/router has an ASIC or Network Processor which performs the packet sampling function. The packet samples and interface counter sampling are forwarded to the central CPU where the sFlow agent is running.

The sFlow Agent maintains linked-lists of Samplers, Pollers, and Receivers. Internally, the agent extracts the interface data of the flow sample from sFlow device, creates new flow sampling data. You can get more specific information of flow samples including input/output interface of sampling ingress/egress packets, VLAN, priority, AS number and so on.

sFlow sampler of agent is in charge of encoding the packet samples and sending them to the receiver.

sFlow poller of the agent collects the sampling of network interface counters. The poller is also in charge of encoding the interface counter data and sending them to the receiver.

Both flow and counter samples are combined in sFlow datagrams. And sFlow receiver encodes those samples into UDP datagrams and sends the datagrams over the network to the sFlow collector.

There are three parts of sFlow agent as shown below:

- **sFlow Agent**
  One agent can hold multiple samplers and pollers, but each sampler and poller points to only one receiver.
  – **Sampler**: This is used to collect packet samples for each interface.
  – **Poller**: This is used to collect counter samples for each interface.
  – **Receiver**: This is used to encode the flow and counter samples into UDP datagrams.

sFlow implementation of the switch has the following restrictions, so you should keep in mind those before configuring sFlow.

- sFlow service must be enabled by **service sflow** command before enabling sFlow function.
- sFlow sampling of specified port would not be perfomed unless you enable sFlow function for each port using **sflow port** *PORTS* **enable** command.
- sFlow sampling would not be performed when sample-rate or counter-interval or receiver index is 0.

7.16.1 sFlow Service

After you enable sFlow service using the following command, the sampling and polling of sFlow interface just start to run in the system.

Enable or disable sFlow service globally, use the following command.

Command	Mode	Description
service sflow	Global	Enables sFlow service globally.
no service sflow		Disables sFlow service globally.

7.16.2 Agent IP Address

To specify IP address of sFlow agent, use the following command.

Command	Mode	Description
sflow agent-ip *A.B.C.D*	Global	Specifies IP address of sFlow agent A.B.C.D: agent IP address (default: 127.0.0.1)
no sflow agent-ip		Deletes specified IP address of sFlow agent.

7.16.3 Enabling sFlow on Port

To enable or disable sFlow function on a port, use the following command.

Command	Mode	Description
sflow port *PORT* **enable**	Global	Enables sFlow function on specified port.
sflow port *PORT* **disable**		Disables sFlow function on specified port.

7.16.4 Maximum IP Header Size

To set the maximum IP header size of sampling packets on a port, use the following command.

Command	Mode	Description
sflow port *PORTS* **max-header-size** <16-256>	Global	Configures the maximum header size of incoming sample packets to specific port. 16-256: maximum IP header size value (default:128)
no sflow port *PORTS* **max-header-size**		Deletes configured maximum header size of sample packets.

7.16.5 Counter Interval

To set the interval to send interface counter information to sFlow poller, use the following command.

Command	Mode	Description
sflow port *PORTS* **counter-interval** <1-1000>	Global	Sets the interval of interface counter for port
no sflow port *PORTS* **counter-interval**		Deletes configured interval of interface counter for port

7.16.6 Sample Rate

To set sampling interval of port, use the following command.

Command	Mode	Description
sflow port *PORTS* **sample-rate** <1-2000>	Global	Specifies sampling interval of port for incoming packets.
no sflow port *PORTS* **sample-rate**		Deletes configured sampling interval of port.

7.16.7 Configuring Receiver

7.16.7.1 Receiver ID mode

To open sFlow receiver mode and configure this receiver in detail, use the following command.

Command	Mode	Description
sflow-receiver <1-65535>	Global	Opens a specific sFlow receiver mode.
no sflow-receiver <1-65535>		Deletes specified sFlow receiver.

7.16.7.2 Collect IP address and port

To specify IP address of sFlow collector, use the following command.

Command	Mode	Description
collect-ip *A.B.C.D*	Receiver	Specifies IP address of sFlow collector. A.B.C.D: IP address of collector (default:0.0.0.0)
no collect-ip		Deletes specified IP address of sFlow collector.

To specify UDP port of sFlow collector, use the following command.

Command	Mode	Description
collect-port <1-65535>	Receiver	Specifies UDP port of sFlow collector 1-65535: UDP port number (default:6343)
no collect-port		Deletes specified UDP port of sFlow collector.

7.16.7.3 Maximum Datagram Size

To set the maximum datagram size of sampling packets which are transmitted through receiver, use the following command.

Command	Mode	Description
max-datagram-size <256-1400>	Receiver	Sets the maximum datagram size of sampling packets that are transmitted by this receiver. 256-1400: maximum datagram size (default:1400)
no max-datagram-size		Deletes the configured maximum datagram size.

7.16.7.4 Owner Name of sFlow Receiver

Owner name of specific receiver represents who is the user of this receiver. If you delete existing owner name of receiver, all configurations including collect-IP, collect-port and timeout of receiver would be also deleted.

To give an owner name of receiver, use the following command.

Command	Mode	Description
owner *NAME*	Receiver	Gives an owner name of specific receiver.
no owner		Deletes the owner name.

7.16.7.5 Timeout

To set a timeout of receiver, use the following command.

Command	Mode	Description
timeout <1-2147483647>	Receiver	Sets a timeout of receiver. 1-2147483647: timeout value (default:0)
no timeout		Deletes configured timeout of receiver.

7.16.8 Receiver Index

If you configure one receiver when sFlow function of specific port was already enabled in the system, you should assign the configured receiver index of that port for transmitting sampling packets to sFlow collector

To specify configured receiver index to port, use the following command.

Command	Mode	Description
sflow port *PORTS* **receiver-index** <1-65535>	Global	Specifies a receiver index of port to transmit sampling packets to sFlow collector. 1-65535: receiver ID
no sflow port *PORTS* **receiver-index**		Deletes specified receiver index of port.

7.16.9 Displaying sFlow

To display the current status of sFlow service, agent IP address, receiver ID and so on, use the following command.

Command	Mode	Description
show sflow	Enable Global	Shows the information of sFlow.

8 System Main Functions

8.1 Virtual Local Area Network (VLAN)

The first step in setting up your bridging network is to define VLAN on your switch. VLAN is a bridged network that is logically segmented by customer or function. Each VLAN contains a group of ports called VLAN members. On the VLAN network, packets received on a port are forwarded only to the ports that belong to the same VLAN as the receiving port. Network devices in different VLANs cannot communicate with one another without a Layer 3 switching device to route traffic between the VLANs. VLAN reduces the amount of broadcast traffic so that flow control could be realized. It also has security benefits by completely separating traffics between different VLANs.

Enlarged Network Bandwidth

Users belonged in each different VLAN can use more enlarged bandwidth than no VLAN composition because they do not receive unnecessary Broadcast information. A properly implemented VLAN will restrict multicast and unknown unicast traffic to only those links necessary to only those links necessary to reach members of the VLAN associated with that multicast (or unknown unicast) traffic.

Cost-Effective Way

When you use VLAN to prevent unnecessary traffic loading because of broadcast, you can get cost-effective network composition since switch is not needed.

Enhanced Security

When using a shared-bandwidth LAN, there is no inherent protection provided against unwanted eavesdropping. In addition to eavesdropping, a malicious user on a shared LAN can also induce problems by sending lots of traffic to specific targeted users or network as a whole. The only cure is to physically isolate the offending user. By creating logical partitions with VLAN technology, we further enhance the protections against both unwanted eavesdropping and spurious transmissions. As depicted in Figure, a properly implemented port-based VLAN allows free communication among the members of a given VLAN, but does not forward traffic among switch ports associated with members of different VLANs. That is, a VLAN configuration restricts traffic flow to a proper subnet comprising exactly those links connecting members of the VLAN. Users can eavesdrop only on the multicast and unknown unicast traffic within their own VLAN: presumably the configured VLAN comprises a set of logically related users.

User Mobility

By defining a VLAN based on the addresses of the member stations, we can define a workgroup independent of the physical location of its members. Unicast and multicast traffic (including server advertisements) will propagate to all members of the VLAN so that they can communicate freely among themselves.

8.1.1 Port-based VLAN

The simplest implicit mapping rule is known as port-based VLAN. A frame is assigned to a VLAN based solely on the switch port on which the frame arrives. In the example depicted in Fig. 8.1, frames arriving on ports 1 through 4 are assigned to VLAN 1, frame from ports 5 through 8 are assigned to VLAN 2, and frames from ports 9 through 12 are assigned to VLAN 3.

Stations within a given VLAN can freely communicate among themselves using either unicast or multicast addressing. No communication is possible at the Data Link layer between stations connected to ports that are members of different VLANs. Communication among devices in separate VLANs can be accomplished at higher layers of the architecture, for example, by using a Network layer router with connections to two or more VLANs.

Multicast traffic, or traffic destined for an unknown unicast address arriving on any port, will be flooded only to those ports that are part of the same VLAN. This provides the desired traffic isolation and bandwidth preservation. The use of port-based VLANs effectively partitions a single switch into multiple sub-switches, one for each VLAN.

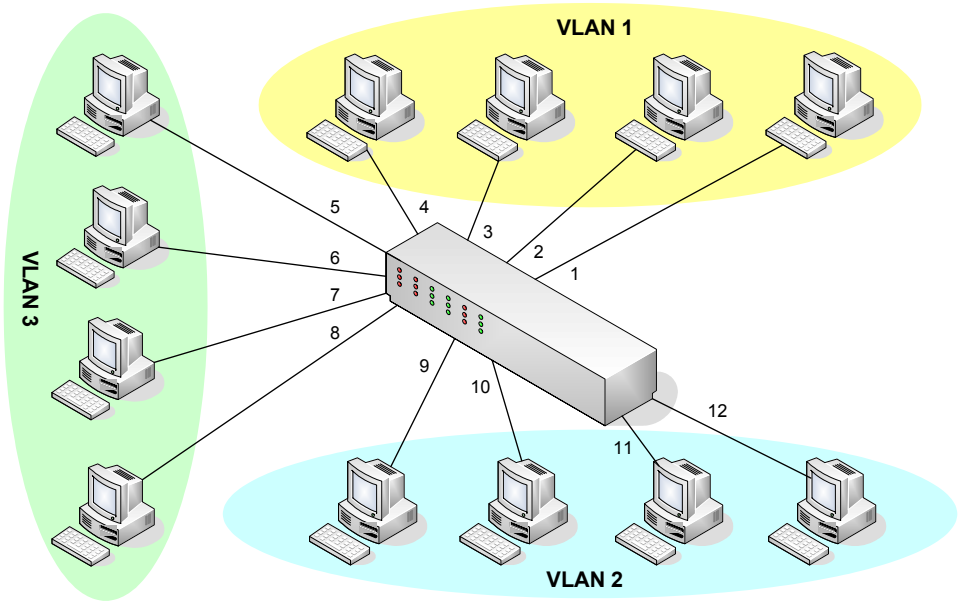


Fig. 8.1 Port-based VLAN

The IEEE 802.1Q based ports on the switches support simultaneous tagged and untagged traffic. An 802.1Q port is assigned a default port VLAN ID (PVID), and all untagged traffic is assumed to belong to the port default PVID. Thus, the ports participating in the VLANs accept packets bearing VLAN tags and transmit them to the port VLAN ID.

The below functions are explained.

- Creating VLAN
- Specifying PVID
- Assigning Port to VLAN
- Deleting VLAN

8.1.1.1 Creating VLAN

To configure VLAN on user's network, use the following command.

Command	Mode	Description
vlan create *VLANS*	Bridge	Creates new VLAN by assigning VLAN ID: VLANS: VLAN ID (1-4094, multiple entries possible)

i The variable VLANS is a particular set of bridged interfaces. The frames are bridged only among interfaces in the same VLAN.

8.1.1.2 Specifying PVID

By default, PVID 1 is specified to all ports. You can also configure a PVID. To configure a PVID in a port, use the following command.

Command	Mode	Description
vlan pvid *PORTS PVIDS*	Bridge	Configures a PVID: PORTS: port numbers PVIDS: PVID (1-4094, multiple entries possible)

8.1.1.3 Assigning Port to VLAN

To assign a port to VLAN, use the following command.

Command	Mode	Description
vlan add *VLANS PORTS* {**tagged** | **untagged**}	Bridge	Assigns a port to VLAN: VLANS: VLAN ID (1-4094) PORTS: port number
vlan del *VLANS PORTS*		Deletes associated ports from specified VLAN: VLANS: VLAN ID (1-4094) PORTS: port number to be deleted

i When you assign several ports to VLAN, you have to enter each port separated by a comma without space or use dash mark "-" to arrange port range.

8.1.1.4 Deleting VLAN

To delete VLAN, use the following command.

Command	Mode	Description
no vlan *VLANS*	Bridge	Deletes VLAN, enter the VLAN ID to be deleted.

i When you delete a VLAN, all ports must be removed from the VLAN; the VLAN must be empty.

8.1.2 Protocol-based VLAN

User can use a VLAN mapping that associates a set of processes within stations to a VLAN rather than the stations themselves. Consider a network comprising devices supporting multiple protocol suites. Each device may have an IP protocol stack, an AppleTalk protocol stack, an IPX protocol stack and so on.

If we configure VLAN-aware switches such that they can associate a frame with a VLAN based on a combination of the station's MAC source address and the protocol stack in use, we can create separate VLANs for each set of protocol-specific applications.

To configure a protocol-based VLAN, follow these steps.

1. Configure VLAN groups for the protocols you want to use.
2. Create a protocol group for each of the protocols you want to assign to a VLAN.
3. Then map the protocol for each interface to the appropriate VLAN.

Command	Mode	Description
vlan pvid *PORTS* **ethertype** *ETHERTYPE VLANS*	Bridge	Adds a port with a protocol-based VLAN. PORTS: port number ETHERTYPE: Ethernet type (e.g. 0x800) VLANS: VLAN ID (1-4094)
no vlan pvid *PORTS* **ethertype** [*ETHERTYPE*]		Deletes a port from a protocol-based VLAN.

Because Protocol Based VLAN and normal VLAN run at the same time, Protocol Based VLAN operates only matched situation comparing below two cases.

1. When Untagged Frame comes in and matches with Protocol VLAN Table, tags PVID which configured on Protocol VLAN. But in no matched situation, tags PVID which configured on and operates VLAN.
2. When Tagged Frame comes in and VID is 0, it switches by Protocol VLAN Table. But if VID is not 0, it switches by normal VLAN Table.

8.1.3 MAC-based VLAN

The switch can assign a frame to a VLAN based on the source MAC address in the received frames. Using this, all frames emitted by a given end station will be assigned to the same VLAN, regardless of the port on which the frame arrives. This is useful for mobility application.

To configure a MAC-based VLAN, follow these steps.

1. Create VLAN groups for the MAC addresses you want to use.
2. Map the MAC address to the appropriate VLAN.

Command	Mode	Description
vlan macbase *MAC-ADDR VLANS*	Bridge	Adds a specified MAC address to a MAC-based VLAN. MAC-ADDR: MAC address of end station VLANS: VLAN ID (1-4094)
no vlan macbase *MAC-ADDR*		Deletes a specified MAC address from a specified MAC address

8.1.4 Subnet-based VLAN

An IP address contains two parts: a subnet identifier and a station identifier. The switch performs two operations to create IP subnet-based VLANs.

- Parse the protocol type to determine if the frame encapsulates an IP datagram.
- Examine and extract the IP subnet portion of the IP Source Address in the encapsulated datagram.

Once it is known that a given frame carries an IP datagram belonging to a given subnet, the switch can transmit the frame as needed within the confines of the subnet to which it belongs. If a device with a given IP address moves within the VLAN-aware network, the boundaries of its IP subnet can automatically adjust to accommodate the station's address.

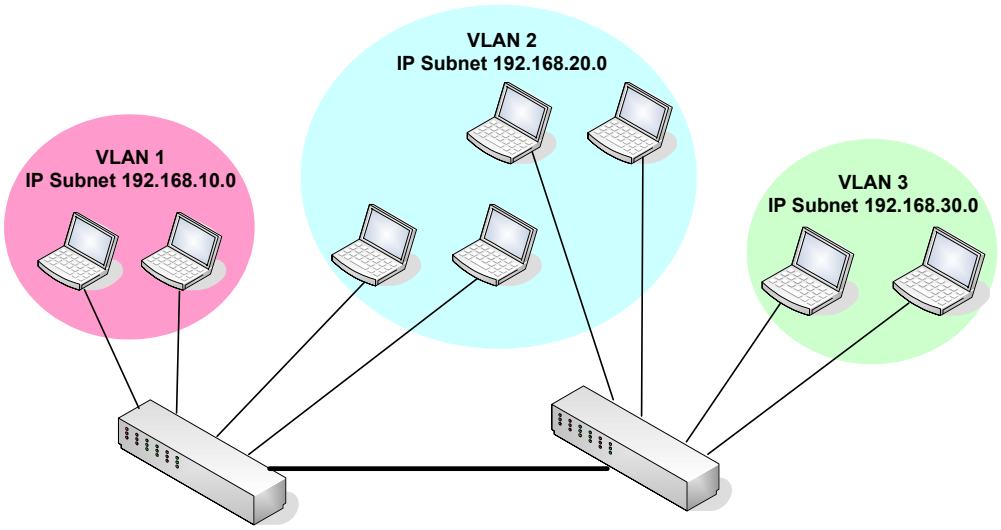


Fig. 8.2 Subnet-based VLAN

To configure subnet-based VLAN, use the following command.

Command	Mode	Description
vlan subnet *A.B.C.D/M VLANS*	Bridge	Configures subnet based VLAN. VLANS: VLAN ID (1-4094)

To clear subnet-based VLAN configuration, use the following command.

Command	Mode	Description
no vlan subnet [*A.B.C.D/M*]	Bridge	Clears configured VLAN based on subnet.

8.1.5 Tagged VLAN

In a VLAN environment, a frame's association with a given VLAN is soft; the fact that a given frame exists on some physical cable does not imply its membership in any particular VLAN. VLAN association is determined by a set of rules applied to the frames by VLAN-aware stations and/or switches.

There are two methods for identifying the VLAN membership of a given frame:
- Parse the frame and apply the membership rules (implicit tagging).
- Provide an explicit VLAN identifier within the frame itself.

VLAN Tag

A VLAN tag is a predefined field in a frame that carries the VLAN identifier for that frame. VLAN tags are always applied by a VLAN –aware device. VLAN-tagging provides a number of benefits, but also carries some disadvantages.

Advantages	Disadvantages
VLAN association rules only need to be applied once.	Tags can only be interpreted by VLAN aware devices.
Only edge switches need to know the VLAN association rules.	Edge switches must strip tags before forwarding frames to legacy devices or VLAN-unaware domains.
Core switches can get higher performance by operating on an explicit VLAN identifier.	Insertion or removal of a tag requires recalculation of the FCS, possibly compromising frame integrity.
VLAN-aware end stations can further reduce the performance load of edge switches.	Tag insertion may increase the length of a frame beyond the maximum allowed by legacy equipment.

Tab. 8.1 Advantages and Disadvantages of Tagged VLAN

Mapping Frames to VLAN

From the perspective the VLAN-aware devices, the distinguishing characteristic of a VLAN is the means used to map a given frame to that VLAN. In the case of tagged frame, the mapping is simple – the tag contains the VLAN identifier for the frame, and the frame is assumed to belong to the indicated VLAN. That's all there is to it.

To configure the tagged VLAN, use the following command.

Command	Mode	Description
vlan add *VLANS PORTS* **tagged**	Bridge	Configures tagged VLAN on a port: VLANS: VLAN ID (1-4094) PORTS: port number

8.1.6 VLAN Description

To specify a VLAN description, use the following command.

Command	Mode	Description
vlan description *VLANS DESC*	Bridge	Specifies a VLAN description. VLANS: VLAN ID (1-4094) DESC: description
no vlan description *VLANS*		Deletes a specified description.

To display a specified VLAN description, use the following command.

Command	Mode	Description
show vlan description	Enable Global Bridge	Shows a specified VLAN description.

8.1.7 VLAN Precedence

To make precedence between MAC address and Subnet based VLAN, you can choose one of both with below command.

Command	Mode	Description
vlan precedence {**mac** | **subnet**}	Bridge	Configure precedence between MAC based VLAN and Subnet based VLAN.

8.1.8 Displaying VLAN Information

User can display the VLAN information about Port based VLAN, Protocol based VLAN, MAC based VLAN, Subnet based VLAN and QinQ.

Command	Mode	Description
show vlan	Enable Global Bridge	Shows all VLAN configurations.
show vlan *VLANS*		Shows a configuration for specific VLAN.
show vlan description		Shows a description for specific VLAN.
show vlan dot1q-tunnel		Shows QinQ configuration.
show vlan protocol		Shows VLAN based on protocol.
show vlan macbase		Shows VLAN based on MAC address.
show vlan subnet		Shows VLAN based on subnet.

8.1.9 QinQ

QinQ or Double Tagging is one way for tunneling between several networks.

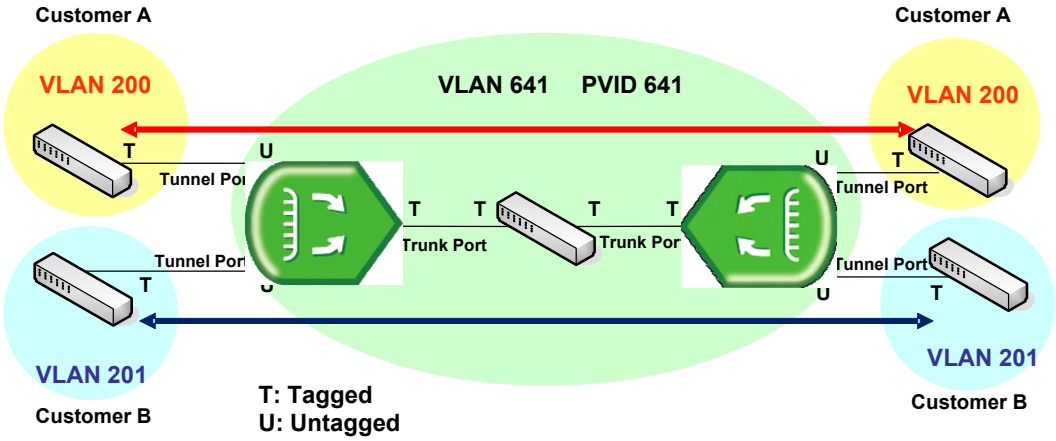


Fig. 8.3 Example of QinQ Configuration

If QinQ is configured on the switch, it transmits packets adding another Tag to original Tag. Customer A group and customer B group can guarantee security because telecommunication is done between each VLANs at Double Tagging part.

Double tagging is implemented with another VLAN tag in Ethernet frame header.

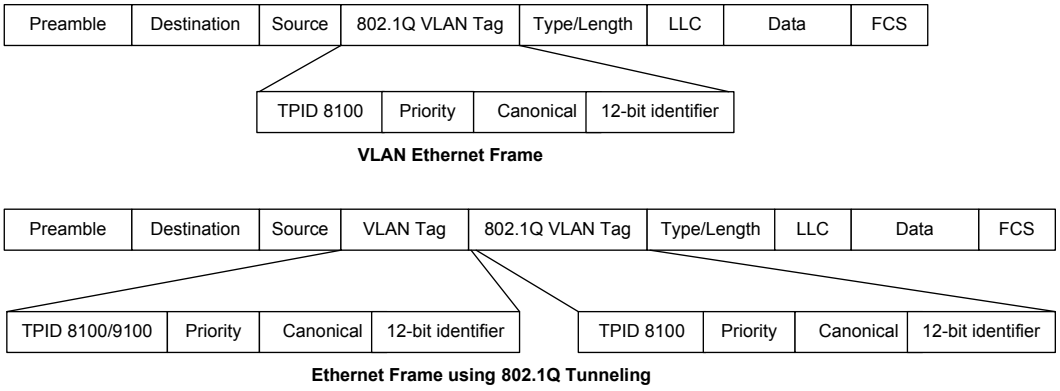


Fig. 8.4 QinQ Frame

Port which connected with Service Provider is Uplink port (internal), and which connected with customer is Access port (external).

Tunnel Port

By tunnel port we mean a LAN port that is configured to offer 802.1Q-tunneling support. A tunnel port is always connected to the end customer, and the input traffic to a tunnel port is always 802.1Q tagged traffic.

The different customer VLANs existing in the traffic to a tunnel port shall be preserved when the traffic is carried across the network

Trunk Port
By trunk port we mean a LAN port that is configured to operate as an inter-switch link/port, able of carrying double-tagged traffic. A trunk port is always connected to another trunk port on a different switch. Switching shall be performed between trunk ports and tunnels ports and between different trunk ports.

8.1.9.1 Double Tagging Operation

Step 1
If there is no SPVLAN Tag on received packet, SPVLAN Tag is added.
SPVLAN Tag = TPID : Configured TPID
VID : PVID of input port

Step 2
If received packet is tagged with CVLAN, the switch transmits it to uplink port changing to SPVLAN + CVLAN. When TPID value of received packet is same with TPID of port, it recognizes as SPVLAN, and if not as CVLAN.

Step 3
If Egress port is Access port (Access port is configured as Untagged), remove SPVLAN. If egress port is uplink port, transmit as it is.

Step 4
The switch switch has 0x8100 TPID value as default and other values are used as hexa-decimal number.

8.1.9.2 Double Tagging Configuration

Step 1
Designate the QinQ port.

Command	Mode	Description
vlan dot1q-tunnel enable *PORTS*	Bridge	Configures a qinq port. PORTS: qinq port to be enabled

Step 2
Configure the same PVID with the VLAN of peer network on the designated qinq port.

Command	Mode	Description
vlan pvid *PORTS* <1-4094>	Bridge	Configures a qinq port. PORTS: qinq port to be enabled 1-4094: PVID

To disable double tagging, use the following command

Command	Mode	Description
vlan dot1q-tunnel disable *PORTS*	Bridge	Configures a qinq port. PORTS: qinq port to be disabled

i When you configure Double tagging on the switch, consider the below attention list.

- DT and HTLS cannot be configured at the same time. (If switch should operate as DT, HTSL has to be disabled.)
- TPID value of all ports on switch is same.
- Access Port should be configured as Untagged, and Uplink port as Tagged.
- Ignore all tag information of port which comes from untagged port (Access Port).
- Port with DT function should be able to configure Jumbo function also

8.1.9.3 TPID Configuration

TPID (Tag Protocol Identifier) is a kind of Tag protocol, and it indicates the currently used tag information. User can change the TPID.

By default the port which is configured as 802.1Q (0x8100) cannot work as VLAN member.

Use the following command to set TPID on a QinQ port.

Command	Mode	Description
vlan dot1q-tunnel tpid *TPID*	Bridge	Configures TPID.

8.1.10 Layer 2 Isolation

Private VLAN is a kind of LAN Security function using by Cisco products, and it can be classified to Private VLAN and Private edge. Until now, there is no standard document of it.

Private VLAN Edge

Private VLAN edge (protected port) is a function in local switch. That is, it cannot work on between two different switches with protected ports. A protected port cannot transmit any traffic to other protected ports.

Private VLAN

Private VLAN provides L2 isolation within the same Broadcast Domain ports. That means another VLAN is created within a VLAN. There are three type of VLAN mode.

- **Promiscuous**: A promiscuous port can communicate with all interfaces, including the isolated and community ports within a PVLAN.
- **Isolated**: An isolated port has complete Layer 2 separation from the other ports within the same PVLAN, but not from the promiscuous ports. PVLANs block all traffic to isolated ports except traffic from promiscuous ports. Traffic from isolated port is forwarded only to promiscuous ports.

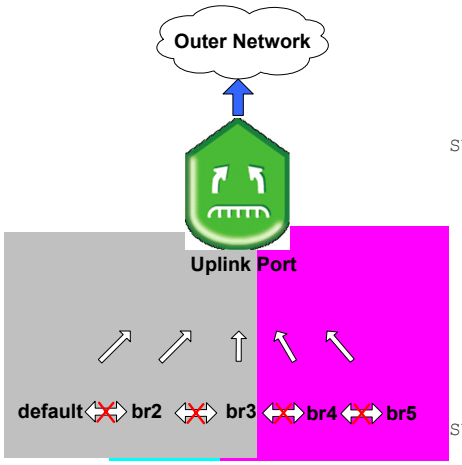
- **Community**: Community ports communicate among themselves and with their promiscuous ports. These interfaces are separated at Layer 2 from all other interfaces in other communities or isolated ports within their PVLAN.

The difference between Private VLAN and Private VLAN edge is that PVLAN edge guarantees security for the ports in a VLAN using protected port and PVLAN guarantees port security by creating sub-VLAN with the three types (Promiscuous, Isolation, and Community). And because PVLAN edge can work on local switch, the isolation between two switches is impossible.

The switch provides Private VLAN function like Private VLAN edge of Cisco product. Because it does not create any sub-VLAN, port security is provided by port isolation. If you want to configure Private VLAN on the switch switch, refer to Port Isolation configuration.

8.1.10.1 Shared VLAN

This chapter is only for Layer 2 switch operation. Because there is no routing information in Layer 2 switch, each VLAN cannot communicate. Especially, the uplink port should receive packets from all VLANs. Therefore when you configure the switch as Layer 2 switch, the uplink ports must be included in all VLANs.




```
SWITCH(bridge)# show vlan
                                u: untagged port, t: tagged port
-------------------------------------------------------------------------
                              |          1         2         3         4
     Name( VID| FID) |123456789012345678901234567890123456789012
-------------------------------------------------------------------------
 default(   1|   1)  |u...uuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuu
     br2(   2|   2)  |.u.....................u...................
     br3(   3|   3)  |..u....................u...................
     br4(   4|   4)  |...u...................u...................
     br5(   5|   5)  |....u..................u...................
SWITCH(bridge)#
```

Fig. 8.5 Outgoing Packets under Layer 2 Shared VLAN Environment

As above configuration with untagged packet, if an untagged packet comes into port 1, it is added with **tag 1** for PVID 1. And the uplink port 24 is also included in the default VLAN; it can transmit to port 24.

However a problem can be occurred for coming down untagged packets to uplink ports. If an untagged packet comes to uplink ports from outer network, the system does not know which PVID it has and where should it forward.

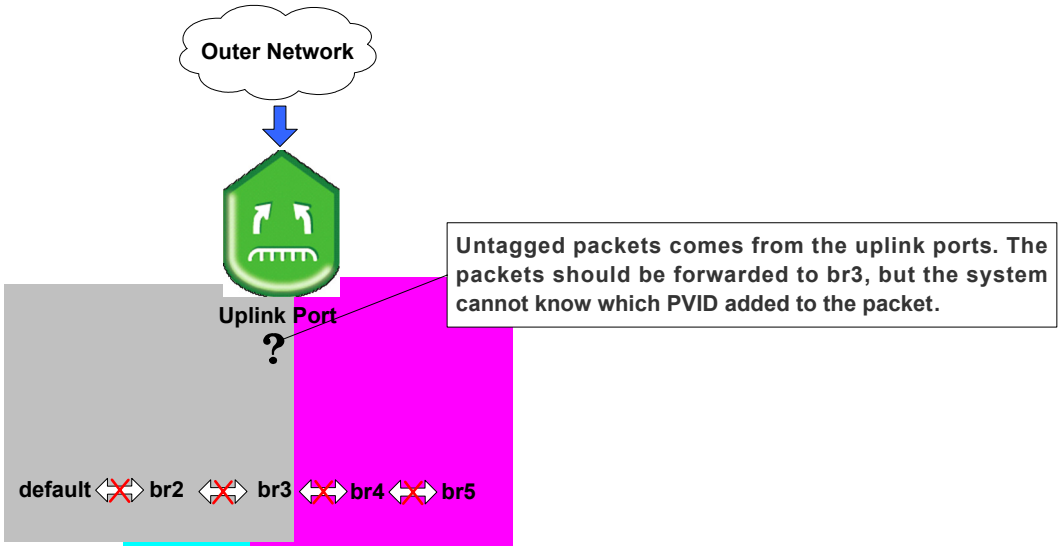
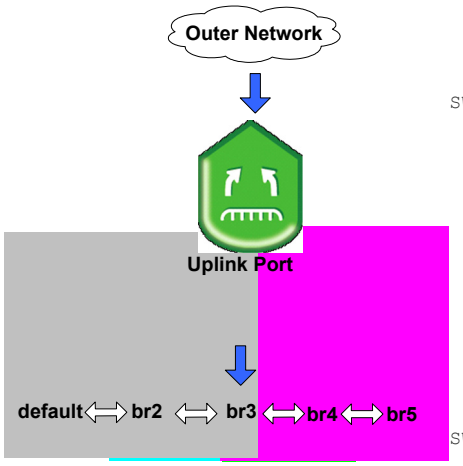


Fig. 8.6 Incoming Packets under Layer 2 Shared VLAN Environment (1)

To transmit the untagged packet from uplink port to subscriber, a new VLAN should be created including all subscriber ports and uplink ports. This makes the uplink ports to recognize all other ports.

FID helps this packet forwarding. FDB is MAC Address Table that recorded in CPU. FDB table is made of FID (FDB Identification). Because the same FID is managed in the same MAC table, it can recognize how to process packet forwarding. If the FID is not same, the system cannot know the information from MAC table and floods the packets.




```
SWITCH(bridge)# show vlan
                                u: untagged port, t: tagged port
-------------------------------------------------------------------------
                          |         1         2         3         4
    Name( VID| FID) |1234567890123456789012345678901234567890123456789012
-------------------------------------------------------------------------
 default(   1|   6) |u...uuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuu
     br2(   2|   6) |.u.....................u...................
     br3(   3|   6) |..u.....................u..................
     br4(   4|   6) |...u.....................u.................
     br5(   5|   6) |....u.....................u................
     br6(   6|   6) |uuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuu
SWITCH(bridge)#
```

Fig. 8.7 Incoming Packets under Layer 2 Shared VLAN Environment (2)

In conclusion, to use the switch as Layer 2 switch, user should add the uplink port to all VLANs and create new VLAN including all ports. If the communication between each VLAN is needed, FID should be same.

To configure FID, use the following command.

Command	Mode	Description
vlan fid *VLANS FID*	Bridge	Configures FID.

8.1.11 VLAN Translation

VLAN Translation is simply an action of Rule. This function is to translate the value of specific VLAN ID which classified by Rule. The switch makes Tag adding PVID on Untagged packets, and use Tagged Packet as it is. That is, all packets are tagged in the Switch, and VLAN Translation is to change the VLAN ID value of Tagged Packet in the Switch. This function is to adjust traffic flow by changing the VLAN ID of packet.

Step 1
Open *Rule Configuration* mode using the **flow** *NAME* **create** command.
See Section 7.6.2.1.

Step 2
Classify the packet that VLAN Translation will be applied by flow.
See Section 7.6.2.2.

Step 3
Designate the VLAN ID that will be changed in the first step by the **match vlan** <1-4094> command.

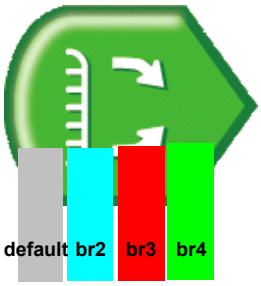
Step 4
Open *Bridge Configuration* mode using the **bridge** command.

Step 5
Add the classified packet to VLAN members of the VLAN ID that will be changed.

8.1.12 Sample Configuration

Sample Configuration 1: Configuring Port-based VLAN

The following is assigning br2, br3, and br4 to port 2, port 3, and port 4.




```
SWITCH(bridge)# vlan create br2
SWITCH(bridge)# vlan create br3
SWITCH(bridge)# vlan create br4
SWITCH(bridge)# vlan del default 2-4
SWITCH(bridge)# vlan add br2 2 untagged
SWITCH(bridge)# vlan add br3 3 untagged
SWITCH(bridge)# vlan add br3 3 untagged
```

```
SWITCH(bridge)# vlan pvid 2 2
SWITCH(bridge)# vlan pvid 3 3
SWITCH(bridge)# vlan pvid 4 4
SWITCH(bridge)# show vlan
                     u: untagged port, t: tagged port
      ------------------------------------------------------------
                       |         1         2         3
          Name( VID| FID) |12345678901234567890123456789012
      ------------------------------------------------------------
       default(   1|   1) |u...uuuuuuuuuuuuuuuuuuuuuuuuuuuuuu
           br2(   2|   2) |.u..............................
           br3(   3|   3) |..u.............................
           br4(   4|   4) |...u............................
SWITCH(bridge)#
```

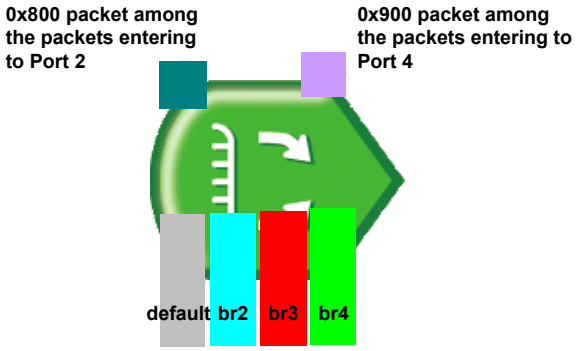
Sample Configuration 2: Deleting Port-based VLAN

The following is deleting br3 among configured VLAN.

```
SWITCH(bridge)# vlan del br3 3
SWITCH(bridge)# exit
SWITCH(config)# interface br3
SWITCH(interface)# shutdown
SWITCH(interface)# exit
SWITCH(config)# bridge
SWITCH(bridge)# no vlan br3
SWITCH(bridge)# show vlan
                     u: untagged port, t: tagged port
      ------------------------------------------------------------
                       |         1         2         3
          Name( VID| FID) |12345678901234567890123456789012
      ------------------------------------------------------------
       default(   1|   1) |u...uuuuuuuuuuuuuuuuuuuuuuuuuuuuuu
           br2(   2|   2) |.u..............................
           br4(   4|   4) |...u............................
SWITCH(bridge)#
```

Sample Configuration 3: Configuring Protocol-based VLAN

The following is an example of configuring protocol based VLAN on the port 2 and port 4.



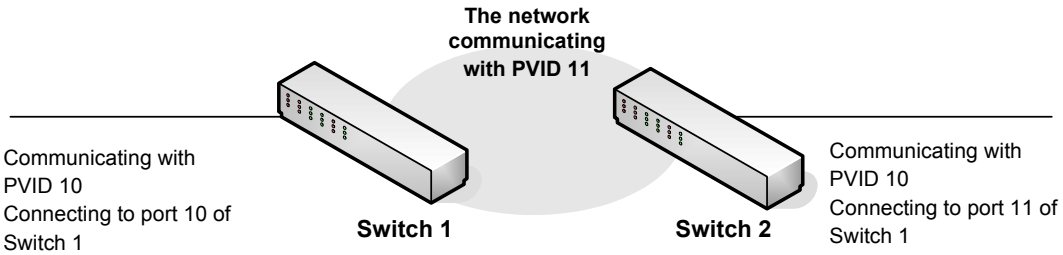

```
SWITCH(bridge)# vlan pvid 2 ethertype 0x800 5
SWITCH(bridge)# vlan pvid 4 ethertype 0x900 6
SWITCH(bridge)# show vlan protocol
        ------------------------------------------------------------
                        |         1         2         3
         Ethertype | VID |12345678901234567890123456789012
        ------------------------------------------------------------
            0x0800     5   .p.....................................
            0x0900     6   ...p..................................
SWITCH(bridge)#
```

With above configuration, the packets from port 2 and 4 are decided according to the protocol kinds. In case the protocol is incongruous, the route is decided according to the port based VLAN.

Sample Configuration 4: Configuring QinQ

Port 10 of SWITCH 1 and port 11 of SWITCH 2 are connected to the network where different VLANs are configured. To communicate without changing VLAN configuration of SWITCH 1 and SWITCH 2 which communicate with PVID 10, configure it as follows.

i You should configure the ports connected to network communicating with PVID 11 as Tagged VLAN port.


The network communicating with PVID 11
Communicating with PVID 10
Connecting to port 10 of Switch 1
Switch 1
Switch 2
Communicating with PVID 10
Connecting to port 11 of Switch 1

< SWITCH 1 >

```
SWITCH(bridge)# vlan dot1q-tunnel enable 10
SWITCH(bridge)# vlan pvid 10 11
SWITCH(bridge)# show vlan dot1q-tunnel
          Tag Protocol Id : 0x8100 (d: double-tagging port)
```

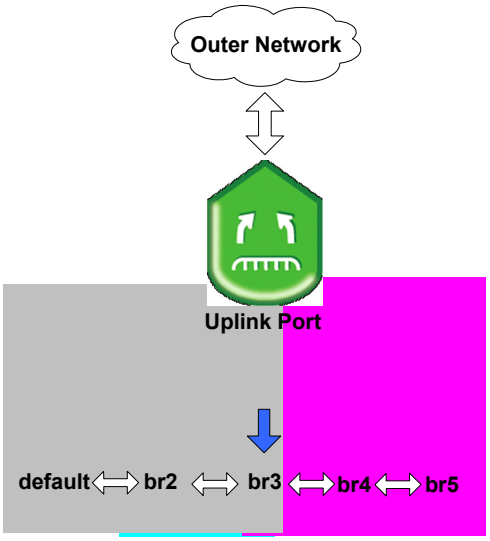
```
-------------------------------------------------
      |         1         2         3
 Port |12345678901234567890123456789012345
-------------------------------------------------
  dtag  .........d.......................
SWITCH(bridge)#
```

< SWITCH 2 >

```
SWITCH(bridge)# vlan dot1q-tunnel enable 11
SWITCH(bridge)# vlan pvid 11 11
SWITCH(bridge)# show vlan dot1q-tunnel
  Tag Protocol Id : 0x8100 (d: double-tagging port)
-------------------------------------------------
      |         1         2         3
 Port |12345678901234567890123456789012345
-------------------------------------------------
  dtag  ..........d..............................
SWITCH(bridge)#
```

Sample Configuration 5: Configuring Shared VLAN with FID

Configure br2, br3, br4 in the switch configured Layer 2 environment and port 24 as Uplink port is configured. To transmit untagged packet through Uplink port rightly, follow below configuration.




```
SWITCH(bridge)# vlan create br2
SWITCH(bridge)# vlan create br3
SWITCH(bridge)# vlan create br4
SWITCH(bridge)# vlan del default 3-8
SWITCH(bridge)# vlan add br2 3,4 untagged
SWITCH(bridge)# vlan add br3 5,6 untagged
SWITCH(bridge)# vlan add br4 7,8 untagged
SWITCH(bridge)# vlan add br2 24 untagged
SWITCH(bridge)# vlan add br3 24 untagged
SWITCH(bridge)# vlan add br4 24 untagged
```

```
SWITCH(bridge)# vlan create br5
SWITCH(bridge)# vlan add br5 1-42 untagged
SWITCH(bridge)# vlan fid 1-5 5
SWITCH(bridge)# show vlan
                      u: untagged port, t: tagged port
       ------------------------------------------------------------------
                         |          1          2          3
          Name( VID| FID) |1234567890123456789012345678901234
       ------------------------------------------------------------------
        default(   1|   5)  |uu......uuuuuuuuuuuuuuuuuuuuuuuuu
            br2(   2|   5)  |..uu...................u..........
            br3(   3|   5)  |....uu.................u..........
            br4(   4|   5)  |......uu...............u..........
            br5(   5|   5)  |uuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuu
SWITCH(bridge)#
```

8.2 Link Aggregation

Link aggregation complying with IEEE 802.3ad bundles several physical ports together to one logical port so that you can get enlarged bandwidth.

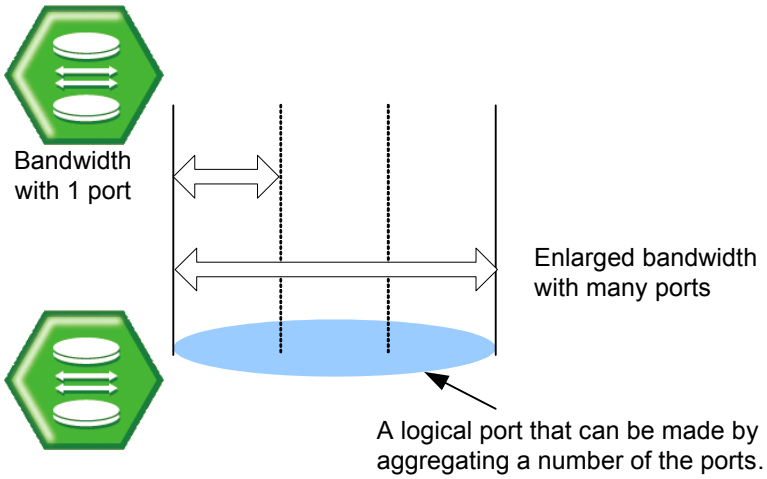


Fig. 8.8 Link Aggregation

The switch supports two kinds of link aggregation as port trunk and LACP. There's a little difference in these two ways. In case of port trunking, it is quite troublesome to set the configuration manually and the rate to adjust to the network environment changes when connecting to the switch using logical port. On the other hand, in case of LACP, once you specify LACP member ports between the switches, the ports will be automatically aggregated by LACP without manually configuring the aggregated ports.

8.2.1 Port Trunk

Port trunking enables you to dynamically group the similarly configured interfaces into a single logical link (aggregate port) to increase bandwidth, while reducing the traffic congestion.

8.2.1.1 Configuring Port Trunk

To create a logical port by aggregating the ports, use the following command.

Command	Mode	Description
trunk <0-4> *PORTS*	Bridge	Adds a port to the aggregation group. 0-4: trunk group ID
trunk distmode { **srcdstip** | **srcdstmac** | **srcdstl4** }		Selects the distribution mode for a specified aggregation group. srcdstmac: refers to source MAC address and destination MAC address. srcdstip: refers to source and destination IP address. srcdstl4: refers to source and destination TCP/UDP.

It is possible to input 0 to 4 as the trunk group ID and the switch supports 5 logical aggregated ports in LACP. The group ID of port trunk and the aggregator ID of LACP cannot have same ID.

For the switch, a source destination MAC address is basically used to decide packet route.

If packets enter to logical port aggregating several ports and there is no way to decide packet route, the packets could be gathered on particular member port so that it is not possible to use logical port effectively. Therefore the switch is configured to decide the way of packet route in order to classify the member ports effectively when packets enter. It is decided with source IP address, destination IP address, source MAC address, destination MAC address and the user could get information of packets to decided packet route.

The port designated as a member port of port trunk is automatically deleted from existing VLAN. Therefore, if the member port and aggregated port exist in different VLAN each other, VLAN configuration should be changed for their aggregation.

8.2.1.2 Disabling Port Trunk

To disable the configured port trunk, use the following command.

Command	Mode	Description
no trunk <0-4> *PORTS*	Bridge	Releases a configured trunk port. 0-4: trunk group ID

If a port is deleted from a logical port or the port trunk is disabled, the port will be added to the default VLAN.

8.2.1.3 Displaying Port Trunk

To display a configuration of port trunk, use the following command.

Command	Mode	Description
show trunk	Enable Global Bridge	Shows a configuration for trunk.

8.2.2 Link Aggregation Control Protocol (LACP)

Link aggregation control protocol (LACP) is the function of using wider bandwidth by aggregating more than two ports as a logical port as previously stated port trunk function.

If the aggregated port by port trunk is in different VLAN from the VLAN where the existing member port originally belongs to, it should be moved to VLAN where the existing member port belongs to. However, the integrated port configured by LACP is automatically added to appropriate VLAN.

LACP can generate up to 5 aggregators whose number value could be 0 to 4. The group ID of trunk port and the aggregator number of LACP cannot be configured with the same value.

The following explains how to configure LACP.

- Configuring LACP
- Operation Mode
- Priority of Switch
- Manual Aggregation
- BPDU Transmission Rate
- Administrational Key
- Port Priority
- Displaying LACP Configuration

8.2.2.1 Configuring LACP

Step 1
Activate LACP function, using the following command.

Command	Mode	Description
lacp aggregator *AGGREGATIONS*	Bridge	Enables LACP of designated Aggregator-number: AGGREGATIONS: select aggregator ID that should be enabled for LACP (valid value from 0 to 4).

Step 2
Configure the physical port that is a member of aggregated port. To configure the member port, use the following command.

Command	Mode	Description
lacp port *PORTS*	Bridge	Configures physical port that is member port of aggregator; select the port number(s) that should be enabled for LACP.

To disable LACP and delete the configuration of LACP, use the following command.

Command	Mode	Description
no lacp aggregator *AGGREGATIONS*	Bridge	Disables LACP for designated Aggregator-number, select the aggregator ID that should be disabled for LACP.
no lacp port *PORTS*		Deletes member port of Aggregator, select the port number(s) that should be disabled for LACP.

8.2.2.2 Operation Mode

After configuring the member port, configure the LACP operation mode of the member port. This defines the operation way for starting LACP operation. You can select the operation mode between the active and passive mode.

The active mode allows the system to start LACP operation regardless of other connected devices. On the other hand, the passive mode allows the system to start LACP operation only when receiving LACP messages from other connected devices.

In case of an LACP connection between 2 switches, if the member ports of both switches are configured as the passive mode, the link between the switches cannot be established.

To configure the operation mode of the member port, use the following command.

Command	Mode	Description
lacp port activity *PORTS* {**active** | **passive**}	Bridge	Configures the operation mode of the member port. (default: active)

To delete the configured operation mode of the member port, use the following command.

Command	Mode	Description
no lacp port activity *PORTS*	Bridge	Deletes the configured operation mode of the member port.

8.2.2.3 Priority of Switch

In case the member ports of connected switches are configured as Active mode (LACP system enabled), it is required to configure which switch would be a standard for it. For this case, the user could configure the priority on switch. The following is the command of configuring the priority of the switch in LACP function.

Command	Mode	Description
lacp system priority <1-65535>	Bridge	Sets the priority of the switch in LACP function, enter the switch system priority. (default: 32768)

To delete the priority of configured switch, use the following command.

Command	Mode	Description
no lacp system priority	Bridge	Clears the priority of the configured switch.

8.2.2.4 Manual Aggregation

The port configured as member port is basically configured to aggregate to LACP. However, even though the configuration as member port is not released, they could operate as independent port without being aggregated to LACP. These independent ports cannot be configured as trunk port because they are independent from being aggregated to LACP under the condition of being configured as member port.

To configure member port to aggregate to LACP, use the following command.

Command	Mode	Description
lacp port aggregation *PORTS* {**aggregatable** | **individual**}	Bridge	Configures the property of a specified member port for LACP. (default: aggregatable)

To clear aggregated to LACP of configured member port, use the following command.

Command	Mode	Description
no lacp port aggregation *PORTS*	Bridge	Deletes the configured property of a specified member port for LACP.

8.2.2.5 BPDU Transmission Rate

Member port transmits BPDU with its information. For the switch, it is possible to configure the BPDU transmission rate, use the following command.

Command	Mode	Description
lacp port timeout *PORTS* {**short** | **long**}	Bridge	Configures BPDU transmission rate: PORTS: select the port number. short: short timeout (1 sec) long: long timeout (30 sec: default)

To delete BPDU transmission rate, use the following command.

Command	Mode	Description
no lacp port timeout *PORTS*	Bridge	Clears BPDU transmission rate of configured member port, select the port number.

8.2.2.6 Administrational Key

Member port of LACP has key value. All member ports in one aggregator have same key values. To make the aggregator consisted of specified member ports, configure the different key value with the key value of another port.

Command	Mode	Description
lacp port admin-key *PORTS* <1-15>	Bridge	Configures the key value of a member port: PORTS: select the port number. 1-15: key value (default: 1)

To delete the key value of a specified member port, use the following command.

Command	Mode	Description
no lacp port admin-key *PORTS*	Bridge	Deletes the key value of a specified member port, select the member port number.

8.2.2.7 Port Priority

To configure priority of an LACP member port, use the following command.

Command	Mode	Description
lacp port priority *PORTS* <1-65535>	Bridge	Sets the LACP priority of a member port, select the port number. (default: 32768)

To delete the configured port priority of the member port, use the following command.

Command	Mode	Description
no lacp port priority *PORTS*	Bridge	Deletes the configured port priority of a selected member port, select the member port number.

8.2.2.8 Displaying LACP Configuration

To display a configured LACP, use the following command.

Command	Mode	Description
show lacp aggregator	Enable Global Bridge	Shows the information of aggregated port.
show lacp aggregator *AGGREGATIONS*		Shows the information of selected aggregated port.
show lacp port		Shows the information of member port.
show lacp port *PORTS*		Shows the information of appropriated member port.
show lacp statistics		Shows aggregator statistics.

To reset LACP statistics information, use the following command.

Command	Mode	Description
clear lacp statistic	Enable Global Bridge	Resets the information of statistics.

8.3 Spanning-Tree Protocol (STP)

The local area network (LAN), which is composed of double paths like token ring, has the advantage that it is possible to access in case of disconnection with one path. However there is another problem called a loop when you always use the double paths.

The loop may occur when double paths are used for the link redundancy between switches and one sends unknown unicast or multicast packet that causes endless packet floating on the LAN like loop topology. That superfluous traffic eventually can result in network fault. It causes superfluous data transmission and network fault.

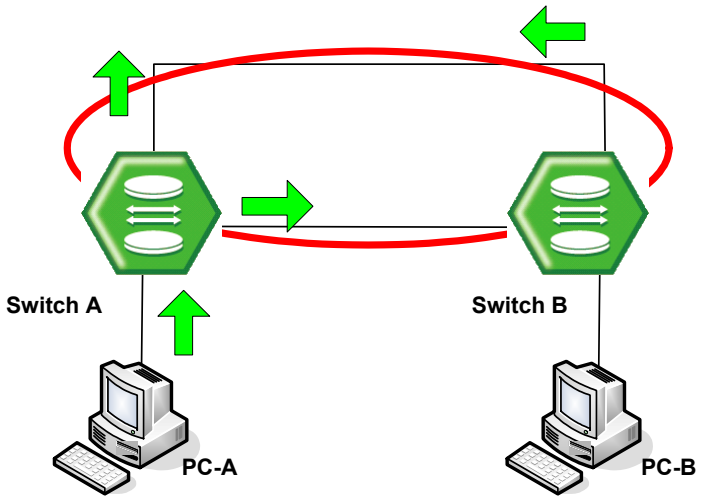


Fig. 8.9 Example of Loop

The spanning-tree protocol (STP) is the function to prevent the loop in LAN with more than two paths and to utilize the double paths efficiently. It is defined in IEEE 802.1d. If the STP is configured in the system, there is no loop since it chooses more efficient path of them and blocks the other path. In other words, when SWITCH C in the below figure sends packet to SWITCH B, path 1 is chosen and path 2 is blocked.

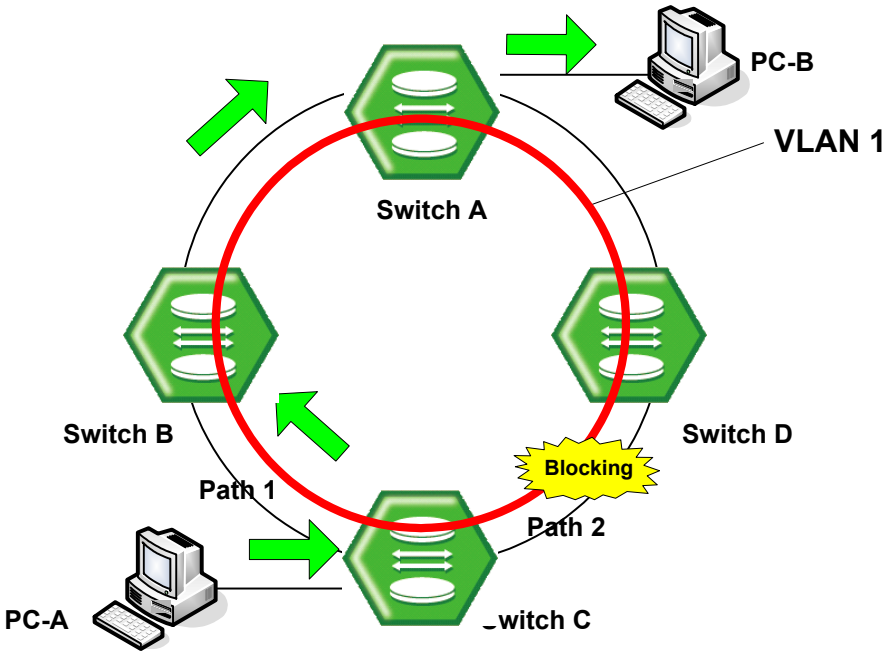


Fig. 8.10 Principle of Spanning Tree Protocol

Meanwhile, the rapid spanning-tree protocol (RSTP) defined in IEEE 802.1w dramatically reduces the time of network convergence on the spanning-tree protocol (STP). It is easy and fast to configure new protocol. The IEEE 802.1w also supports backward compatibility with IEEE 802.1d.

The switch provides STP, RSTP and MSTP. For more detail description of STP and RSTP, refer to the following sections.

- STP Operation
- RSTP Operation
- MSTP Operation
- Enabling STP Function (Required)
- Configuring MSTP/PVSTP Mode
- STP Basic Configuration
- Configuring MSTP
- Configuring PVSTP
- Root Guard
- Restarting Protocol Migration
- Loop Back Detection
- BPDU Configuration
- Sample Configuration

8.3.1 STP Operation

The 802.1d STP defines port state as blocking, listening, learning, and forwarding. When STP is configured in LAN with double paths, switches exchange their information including the bridge ID.

It is named as BPDU (Bridge Protocol Data Unit). Switches decide port state based on the exchanged BPDU and automatically decide an optimized path to communicate with the root switch.

Root Switch

The critical information to decide a root switch is the bridge ID. Bridge ID is composed of two bytes-priority and six bytes-MAC address. The root switch is decided with the lowest bridge ID.

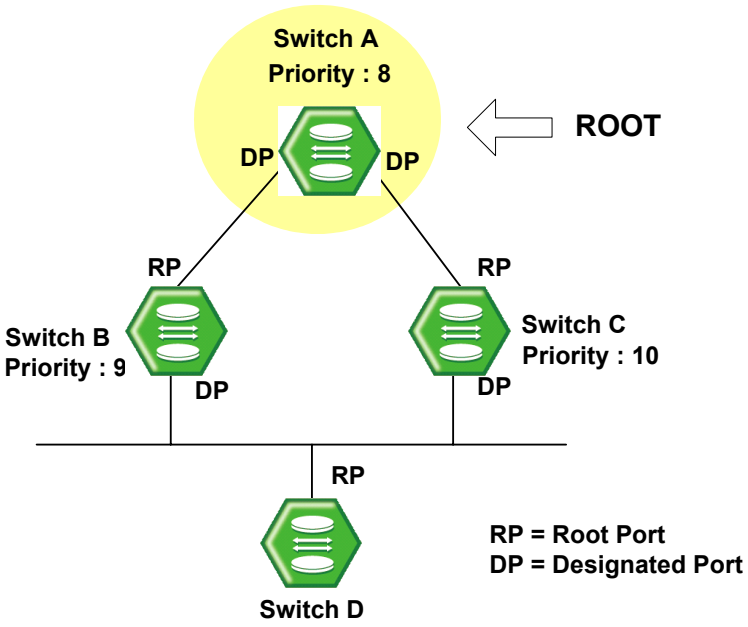


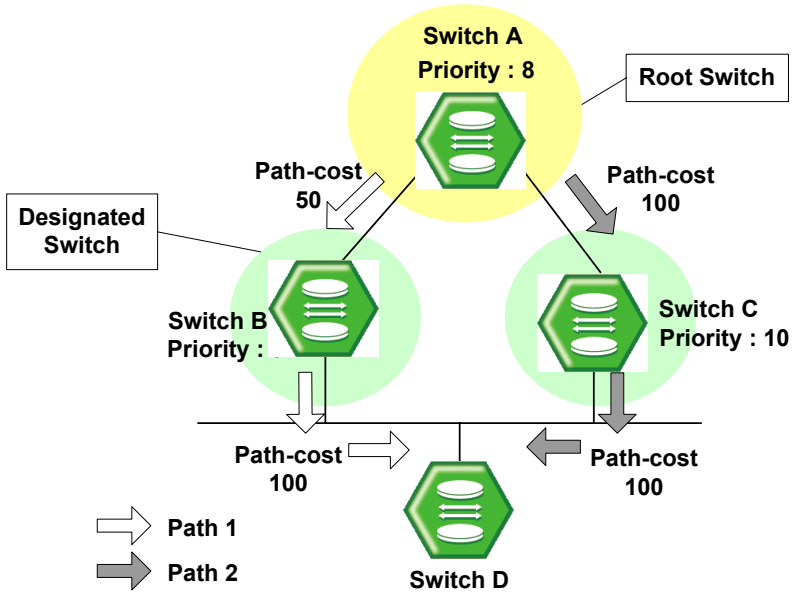
Fig. 8.11 Root Switch

After configuring STP, switches exchange their information. The priority of SWITCH A is 8, the priority of SWITCH B is 9 and the priority of SWITCH C is 10. In this case, SWITCH A is automatically configured as root switch.

Designated Switch

After deciding a root switch, when SWITCH A transmits packet to SWITCH C, SWITCH A compares the exchanged BPDU to decide a path. The critical information to decide path is path-cost. Path-cost depends on the transmit rate of LAN interface and path with lower path-cost is selected.

The standard to decide a designated switch is total root path-cost which is added with path-cost to the root switch. Path-cost depends on transmit rate of switch LAN interface and switch with lower path-cost is selected to be a designated switch.



(PATH 1 = 50 + 100 = 150, PATH 2 = 100 + 100 = 200, PATH 1 < PATH 2, ∴ **PATH 1 selected**

Fig. 8.12 Designated Switch

In case of the above picture showing SWITCH C sends packet, path-cost of PATH 1 is 150 and path- cost of PATH 2 is total 200(100 + 100 ; path-cost of SWITCH C to B + path-cost of SWITCH B to C). Therefore lower path-cost, PATH 1 is chosen. In this case, port connected to root switch is named root port. In the above picture, port of SWITCH C connected to SWITCH A as Root switch is root port. There can be only one root port on equipment.

i When root path-costs are same, bridge ID is compared.

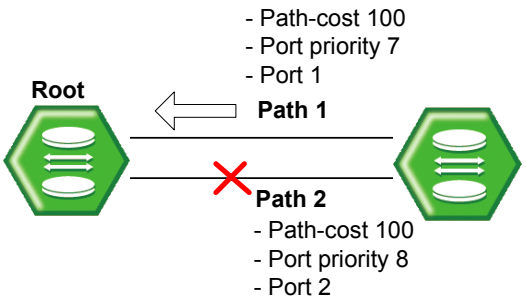
Designated Port and Root Port

A root port is the port in the active topology that provides connectivity from the designated switch toward the root. A designated port is a port in the active topology used to forward traffic away from the root onto the link for which this switch is the designated switch. That is; except root port in each switch, the selected port to communicate is a designated port.

Port Priority

Meanwhile, when the path-cost of two paths are same, port-priority is compared. As the below picture, suppose that two switches are connected. Since the path-costs of two paths are 100, same, their port priorities are compared and port with smaller port priority is selected to transmit packet.

i All these functions are automatically performed by BPDU, which is the bridge information exchanged between switches to activate or disable a specific port. It is also possible to configure BPDU to change a root switch or path manually.



(path-cost of PATH 1 = path-cost of PATH 2 = 100 ∴ unable to compare
PATH 1 port priority = 7, PATH 2 port priority = 8, PATH 1 < PATH 2, ∴ **PATH 1 is chosen**)

Fig. 8.13 Port Priority

Port States

Each port on a switch can be in one of five states.

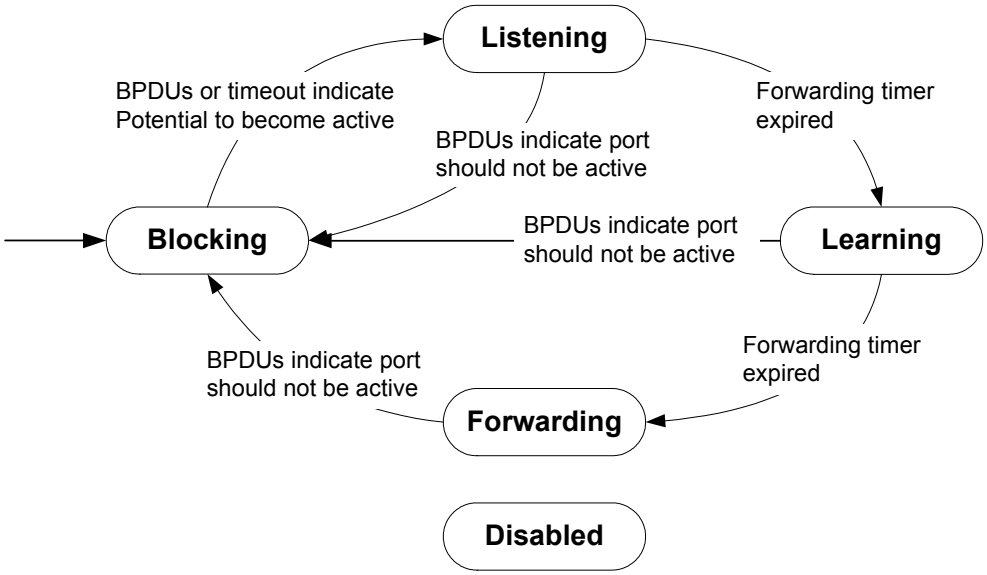


Fig. 8.14 Port State

- **Blocking**
  a port that is enabled, but that is neither a Designated port nor a Root port, will be in the blocking state. A blocking port will not receive or forward data frames, nor will it transmit BPDUs, but instead it will listen for other's BPDUs to determine if and when the port should consider becoming active in the spanning tree.
- **Listening**
  the port is still not forwarding data traffic, but is listening to BPDUs in order to compute the spanning tree. The port is comparing its own information (path cost, Bridge Identifier, Port Identifier) with information received from other candidates and deciding which is best suited for inclusion in the spanning tree.

- **Learning**
  the port is preparing to forward data traffic. The port waits for a period of time to build its MAC address table before actually forwarding data traffic. This time is the forwarding delay.
- **Forwarding**
  After some time learning address, it is allowed to forward data frame. This is the steady state for a switch port in the active spanning tree.
- **Disabled**
  When disabled, a port will neither receive nor transmit data or BPDUs. A port is in this state because it is broken or disabled by administrator.

8.3.2 RSTP Operation

STP or RSTP is configured on network where Loop can be created. However, RSTP is more rapidly progressed than STP at the stage of reaching to the last topology. This section describes how the RSTP more improved than STP works. It contains the below sections.

- Port States
- BPDU Policy
- Rapid Network Convergence
- Compatibility with 802.1d

8.3.2.1 Port States

RSTP defines port states as discarding, learning, and forwarding. Blocking of 802.1d and listening is combined into discarding. Same as STP, root port and designated port are decided by port state. But a port in blocking state is divided into alternate port and backup port. An alternate port means a port blocking BPDUs of priority of high numerical value from other switches, and a backup port means a port blocking BPDUs of priority of high numerical value from another port of same equipment.

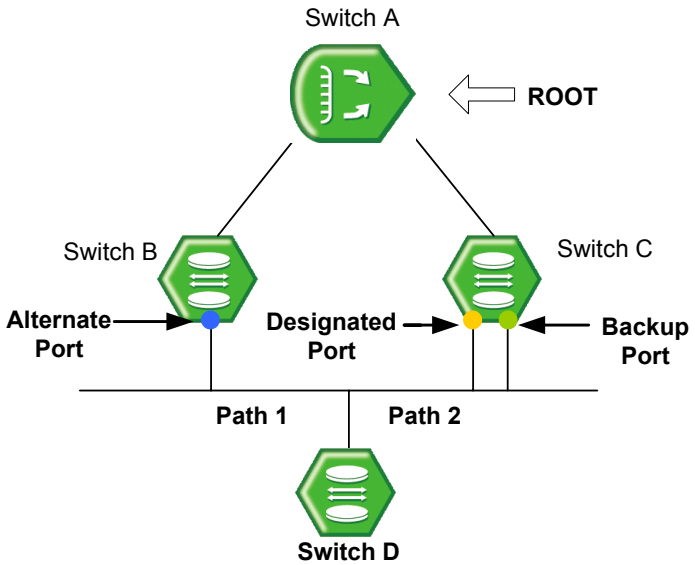


Fig. 8.15 Alternate Port and Backup port

The difference of between alternate port and backup port is that an alternate port can alternate the path of packet when there is a problem between Root switch and SWITCH C but Backup port cannot provide stable connection in that case.

8.3.2.2 BPDU Policy

In 802.1d, only root switch can generate BPDU every hello time and other swithches cannot. They can create BPDU when receiving BPDU from the root switch. However, in 802.1w not only root switch but also all the other switches forward BPDU following Hello-time. BPDU is more frequently issued than the interval the root switch exchanges, but with 802.1w conversion to the forwarding state become faster to keep up with changing network.

By the way, when low BPDU is received from root switch or designated switch, it is immediately accepted. For example, suppose that root switch is disconnected to SWITCH B. Then, SWITCH B is considered to be root because of the disconnection and forwards BPDU.

However, SWITCH C recognizes root existing, so it transmits BPDU including information of root to Bridge B. Thus, SWITCH B configures a port connected to SWITCH C as new root port.

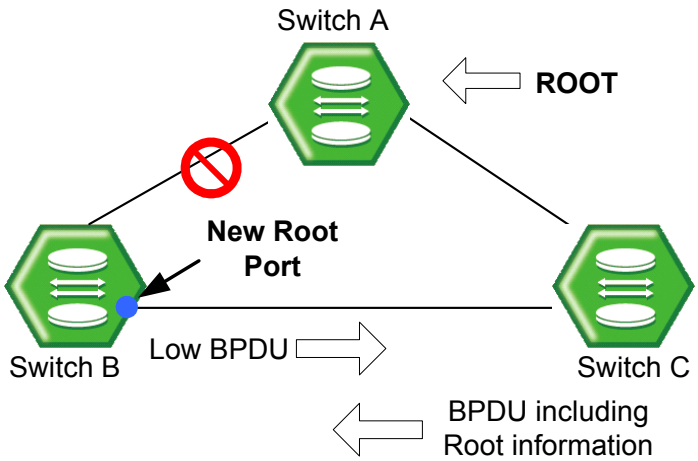


Fig. 8.16 Example of Receiving Low BPDU

8.3.2.3 Rapid Network Convergence

A new link is connected between SWITCH A and root. Root and SWITCH A is not directly connected, but indirectly through SWITCH D. After SWITCH A is newly connected to root, packet cannot be transmitted between the ports because state of two switches becomes listening, and no loop is created.

In this state, if root transmits BPDU to SWITCH A, SWITCH A transmits new BPDU to SWITCH A and SWITCH C, switch C transmits new BPDU to SWITCH D. SWITCH D, which received BPDU from SWITCH C makes port connected to SWITCH C Blocking state to prevent loop after new link.

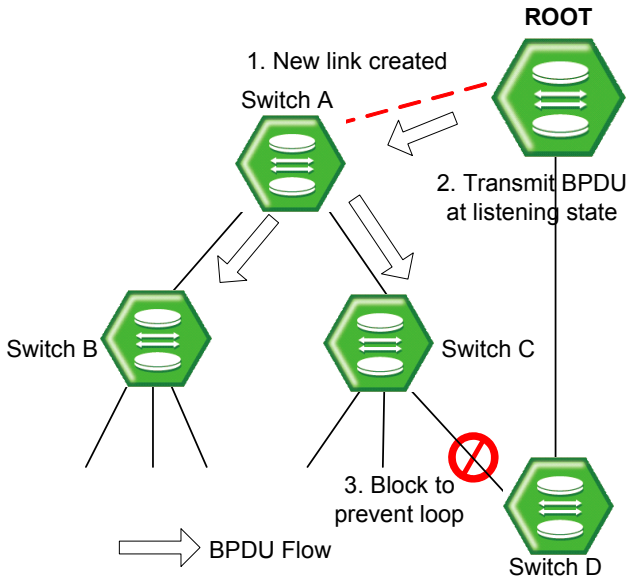


Fig. 8.17 Network Convergence of 802.1d

This is very epochal way of preventing a loop. The matter is that communication is disconnected during two times of BPDU Forward-delay till a port connected to switch D and SWITCH C is blocked. Then, right after the connection, it is possible to transmit BPDU although packet cannot be transmitted between switch A and root.

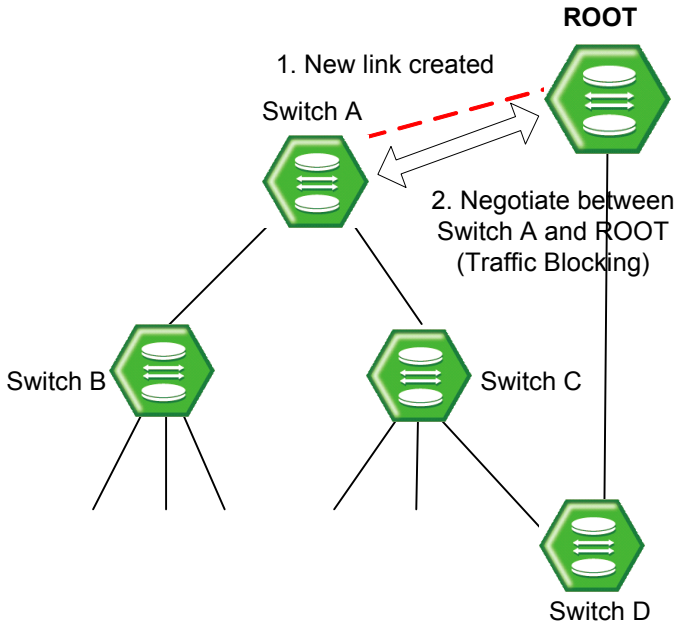


Fig. 8.18 Network Convergence of 802.1w (1)

SWITCH A negotiates with root through BPDU. To make link between SWITCH A and root, port state of non-edge designated port of SWITCH is changed to blocking. Although SWITCH A is connected to root, loop will not be created because SWITCH A is blocked to

SWITCH Band C. In this state, BPDU form root is transmitted to SWITCH B and C through SWITCH A. To configure forwarding state of SWITCH A, SWITCH A negotiates with SWITCH B and SWITCH C.

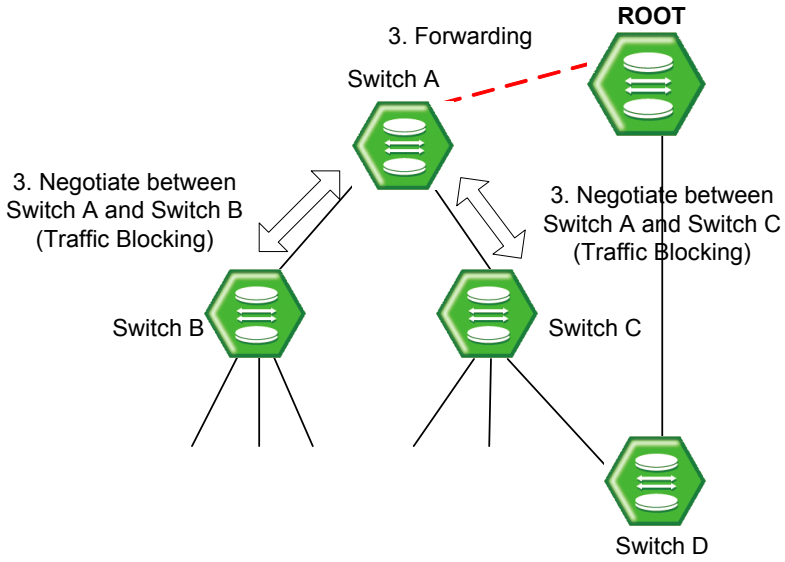


Fig. 8.19 Network Convergence of 802.1w (2)

SWITCH B has only edge-designated port. Edge designated does not cause loop, so it is defined in 802.1w to be changed to forwarding state. Therefore, SWITCH B does not need to block specific port to forwarding state of SWITCH A. However since SWITCH C has a port connected to SWITCH D, you should make blocking state of the port.

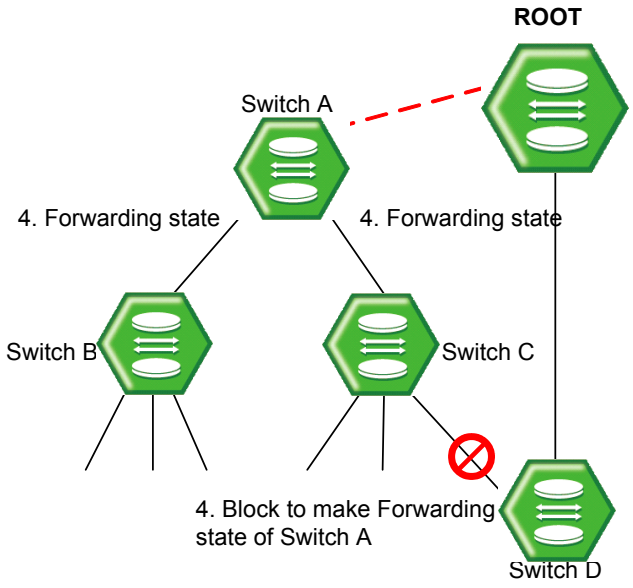


Fig. 8.20 Network Convergence of 802.1w (3)

It is same with 802.1d to block the connection of SWITCH D and SWITCH C. However, 802.1w does not need any configured time to negotiate between switches to make forwarding state of specific port. So it is very fast progressed. During progress to forwarding state of port, listening and learning are not needed. These negotiations use BPDU.

8.3.2.4 Compatibility with 802.1d

RSTP internally includes STP, so it has compatibility with 802.1d. Therefore, RSTP can recognize BPDU of STP. But, STP cannot recognize BPDU of RSTP. For example, assume that SWITCH A and SWITCH B are operated as RSTP and SWITCH A is connected to SWITCH C as designated switch. Since SWITCH C, which is 802.1d ignores RSTP BPDU, it is interpreted that switch C is not connected to any switch or segment.

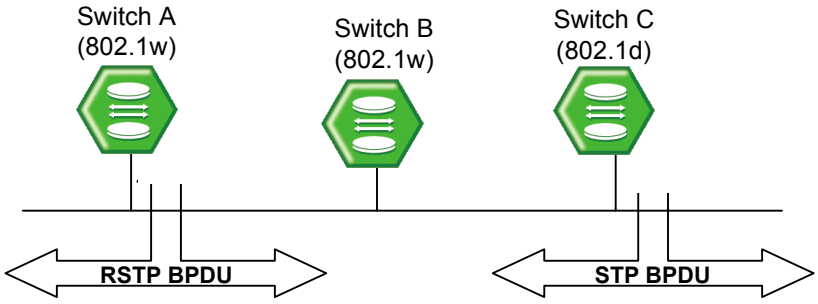


Fig. 8.21 Compatibility with 802.1d (1)

However, SWITCH A converts a port received BPDU into RSTP of 802.1d because it can read BPDU of SWITCH C. Then SWITCH C can read BPDU of SWITCH A and accepts SWITCH A as designated switch.

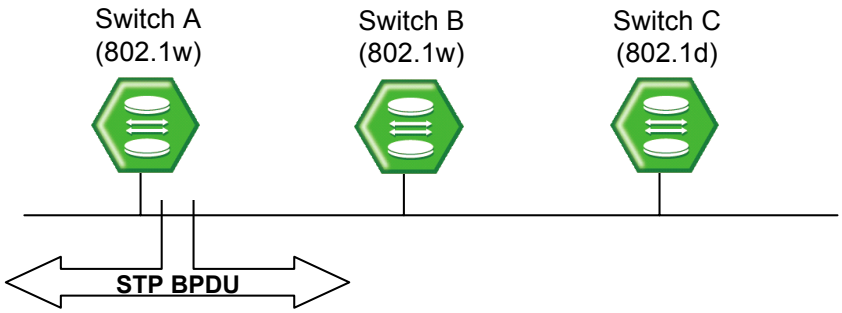


Fig. 8.22 Compatibility with 802.1d (2)

8.3.3 MSTP Operation

To operate the network more efficiently, the switch uses MSTP (Multiple Spanning-Tree Protocol). It constitutes the network with VLAN subdividing existing LAN domain logically and configure the route by VLAN or VLAN group instead of existing routing protocol.

Here explains how MSTP/PVSTP differently operates on the LAN. Suppose to configure 100 VLANs from SWITCH A to B and C. In case of STP, there is only one STP on all the VLANs and it does not provide multiple instances.

While the existing STP is a protocol to prevent a loop in a LAN domain, MSTP establishes STP per VLAN in order to realize routing suitable to VLAN environment. It does not need to calculate all STPs for several VLANs so that traffic overload could be reduced. By reducing unnecessary overload and providing multiple transmission routes for data forwarding, it realizes load balancing and provides many VLANs through Instances.

8.3.3.1 MSTP

In MSTP, VLAN is classified to groups with same configuration ID. Configuration ID is composed of revision name, region name and VLAN/instance mapping. Therefore, to have same configuration ID, all of these tree conditions should be the same. VLAN classified with same configuration ID is called an MST region. In a region, there is only one STP so that it is possible to reduce the number of STP comparing to PVSTP. There's no limitation for region in a network environment but it is possible to generate Instances up to 64. Therefore instances can be generated from 1 to 64. Spanning-tree which operates in each region is IST (Internal Spanning-Tree). CST is applied by connecting each spanning-tree of region. Instance 0 means that there is not any Instance generated from grouping VLAN, that is, it does not operate as MSTP. Therefore Instance 0 exists on all the ports of the equipment. After starting MSTP, all the switches in CST exchange BPDU and CST root which is decided by comparing their BPDU. Here, the switches that do not operate with MSTP have instance 0 so that they can also join BPUD exchanges. The operation of deciding CST root is CIST (Common & Internal Spanning-Tree).

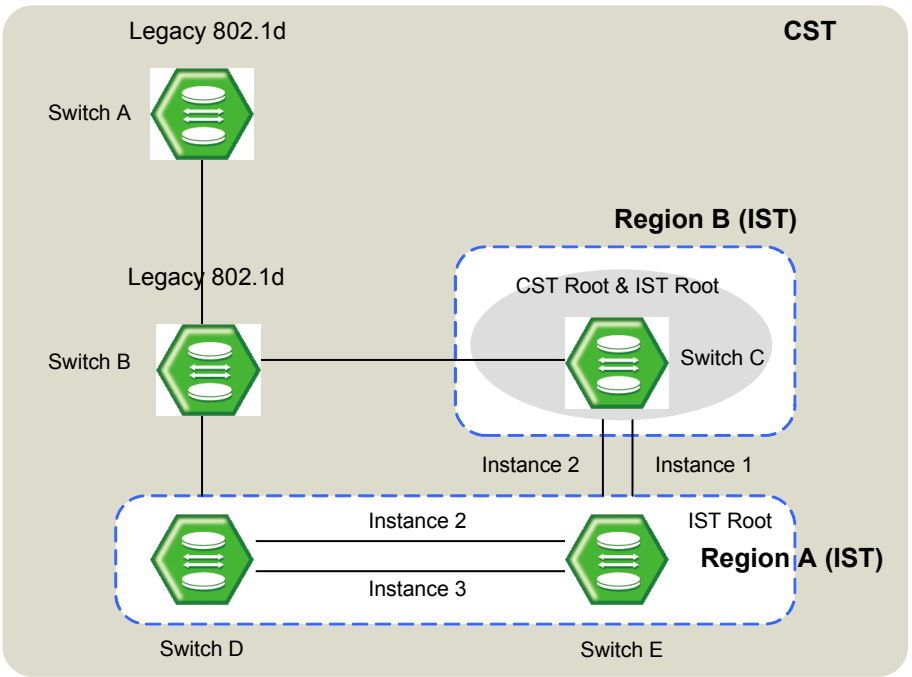


Fig. 8.23 CST and IST of MSTP (1)

In CST, SWITCH A and B are operating with STP and SWITCH C, D and E are operating with MSTP. First, in CST, CIST is established to decide a CST root. After the CST root is decided, the closest switch to the CST root is decided as IST root of the region. Here, CST root in IST is an IST root.

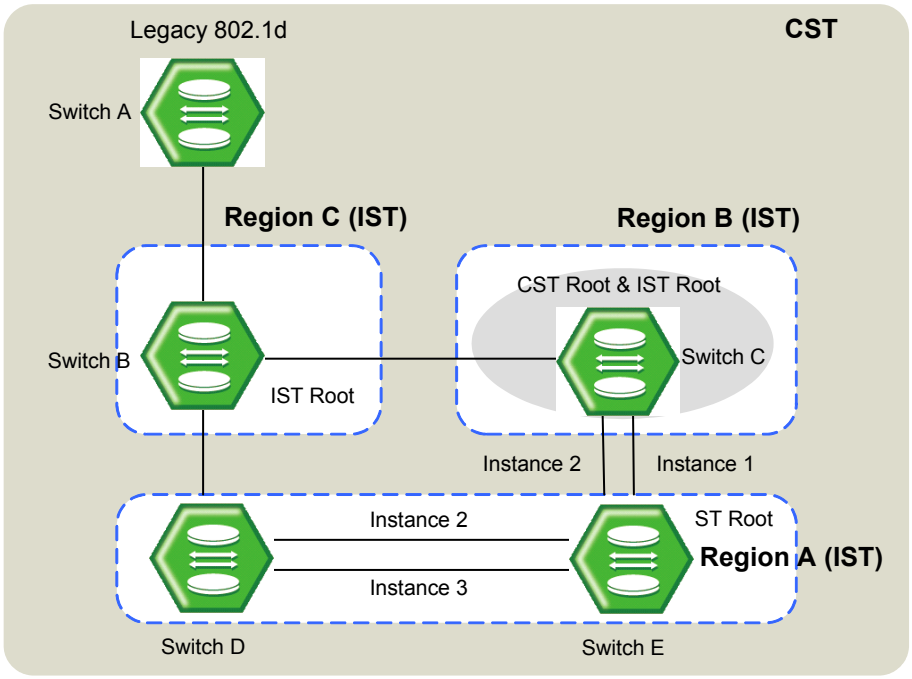


Fig. 8.24 CST and IST of MSTP (2)

In the above situation, if SWITCH B operates with MSTP, it will send its BPDU to the CST root and IST root in order to request itself to be a CST root. However, if any BPDU having higher priority than that of SWITCH B is sent, SWITCH B cannot be a CST root.

8.3.4 Enabling STP Function (Required)

First of all, you need to enable STP function. You cannot configure any parameters related to Spanning Tree Protocol without this command.

To enable STP function on the switch, use the following command.

Command	Mode	Description
spanning-tree	Bridge	Enables STP function.

To disable STP function from the system, use the following command.

Command	Mode	Description
no spanning-tree	Bridge	Disables STP function.

8.3.5 Configuring MSTP/PVSTP Mode

To select the spanning-tree mode, use the following command.

Command	Mode	Description
spanning-tree mode { **mst** | **rapid-pvst**}	Bridge	Configures a spanning-tree mode: mst: Multiple Spanning Tree Protocol (default) rapid-pvst: Per-vlan Rapid STP

To delete the configured spanning-tree mode, use the following command.

Command	Mode	Description
no spanning-tree mode	Bridge	Deleted a configured spanning-tree mode.

8.3.6 STP Basic Configuration

To configure STP, use the following steps.

Step 1
Enable STP function using the **spanning-tree** command.

Step 2
Configure detail options if specific commands are required.

8.3.6.1 Path-cost Method

After deciding a root switch, you need to decide to which route you will forward the packet. To do this, the standard is a path-cost.

Generally, a path cost depends on the transmission speed of LAN interface in the switch. The following table shows the path cost according to the transmit rate of LAN interface.

You can use same commands to configure STP and RSTP, but their path-costs are totally different. Please be careful not to make mistake.

Transmit Rate (bps)	Path-cost
4M	250
10M	100
100M	19
1G	4
10G	2

Tab. 8.2 STP Path-cost (short)

Transmit Rate (bps)	Path-cost
4M	20000000
10M	2000000
100M	200000
1G	20000
10G	2000

Tab. 8.3 RSTP Path-cost (long)

To decide the path-cost calculation method, use the following command.

Command	Mode	Description
spanning-tree pathcost method long	Bridge	Selects the method for calculating a RSTP path-cost: long: 32 bits of RSTP path-cost (IEEE 802.1D-2004).
spanning-tree pathcost method short		Selects the method for calculating a STP path-cost: short: 16bits of STP path-cost (IEEE 802.1D-1998).

To delete a configured method for caculating the path-cost and return the configuration to the default, use the following command.

Command	Mode	Description
no spanning-tree pathcost method	Bridge	Deletes the configured method of path-cost. (default: short)

When the route decided by path-cost gets overloading, you would better take another route. Considering these situations, it is possible to configure the path-cost of root port so that user can configure a route manually.

To configure the path-cost, use the following command.

Command	Mode	Description
spanning-tree port *PORTS* **cost** <1-200000000>	Bridge	Configures path-cost to configure route: PORTS: port number. 1-200000000: the path cost value.
no spanning-tree port *PORTS* **cost**		Deletes the configured path-cost, enter the port number.

8.3.6.2 Edge Ports

Edge ports are defined that the ports are connected to a nonbridging device. There are no switches or spanning-tree bridges directly connected to the edge port.

To configure all ports as edge ports globally, use the following command.

Command	Mode	Description
spanning-tree edgeport default	Bridge	Configures all ports as edge ports: PORTS: port number.
no spanning-tree edgeport default		Deleted a configured edge ports for all ports. (default)

To configure a specified port as edge port, use the following command.

Command	Mode	Description
spanning-tree port *PORTS* **edgeport enable**	Bridge	Configures specified port as edge port. PORTS: port number.
spanning-tree port *PORTS* **edgeport disable**		Disables edge port for specified port. PORTS: port number

8.3.6.3 BPDU Transmit hold count

You can configure the BPDU burst size by changing the transmit hold count value. To configure the transmit hold-count, use the following command.

Command	Mode	Description
spanning-tree transmit hold-count <0-20>	Bridge	Sets the number of BPDUs that can be sent before pausing for 1 second: 0-20: BPDU transmit hold-count value (default:6)
no spanning-tree transmit hold-count		Deletes a configured transmit hold-count value and returns to the default setting.

If you change this parameter to a higher value can have a significant impact on CPU utilization, especially in Rapid-PVST mode. We recommend that you maintain the default setting.

8.3.6.4 Port Priority

When all conditions of two switches are same, the last standard to decide route is port-priority. It is also possible to configure port priority so that user can configure route manually. To configure the port-priority, use the following command.

Command	Mode	Description
spanning-tree port *PORTS* **port-priority** <0-240>	Bridge	Configures port priority. PORTS: port number 0-240: port priority in increments of 16 (default:128)
no spanning-tree port *PORTS* **port-priority**		Deleted a configured port priority.

8.3.6.5 Link Type

A port that operates in full-duplex is assumed to be point-to-point link type, while a half-duplex is considered as a shared port. .

To configure the link type of port, use the following command.

Command	Mode	Description
spanning-tree port *PORTS* **link-type** {**point-to-point** | **shared**}	Bridge	Specifies a link-type for a designated port PORTS: port number point-to-point: full-duplex shared: half-duplex

To delete a configured link type of port, use the following command.

Command	Mode	Description
no spanning-tree port *PORTS* **link-type**	Bridge	Deletes a configured link type.

8.3.6.6 Displaying Configuration

To display the configurations of STP, use the following command.

Command	Mode	Description
show spanning-tree	Enable Global Bridge	Shows all configurations of STP
show spanning-tree active [**detail**]	Bridge	Shows STP information on active interface: detail: detailed STP information (as option).
show spanning-tree blockedport		Shows information of the blocked ports
show spanning-tree detail [**active**]		Shows detailed information of STP.
show spanning-tree inconsistentports		Shows information of root-inconsistency state.
show spanning-tree bridge [{ **address** | **detail** | **forward-time** | **hello-time** | **id** | **max-age** | **protocol** | **priority** [**system-id**] }]		Shows information of the bridge status and configuration
show spanning-tree root [{ **address** | **cost** | **detail** | **forward-time** | **hello-time** | **id** | **max-age** | **port** | **priority** [**system-id**] }]		Shows the status and configuration for the root bridge.
show spanning-tree port *PORTS* [{ **active** [**detail**] | **cost** | **detail** [**active**] | **edgeport** | **inconsistency** | **rootcost** | **state** | **priority** }]		Shows STP information of specified port.
show spanning-tree summary [**totals**]		Shows a summary of STP: totals: the total lines of STP

8.3.7 Configuring MSTP

To configure MSTP, use the following steps.

Step 1
Enable STP function using the **spanning-tree** command.

Step 2
Select a MSTP mode using the **spanning-tree mode mst** command.

Step 3
Configure detail options if specific commands are required.

Step 4

Enable a MSTP daemon using the **spanning-tree mst** command.

8.3.7.1 Root Switch

To establish MSTP function, a root switch should be chosen first. In MSTP, a root switch is called as IST root switch. Each switch has its own bridge ID, and one of the switchs on same LAN is chosen as a root switch by comparing with their bridge IDs. However, you can configure the priority and make it more likely that the switch will be chosen as the root switch. The switch having the lowest priority becomes the root switch.

To configure the priority for an MSTP instance number, use the following command.

Command	Mode	Description
spanning-tree mst <0-64> **priority** <0-61440>	Bridge	Configures the priority of the switch: 0-64: MSTP instance ID number. 0-61440: priority value in increments of 4096 (default: 32768)
no spanning-tree mst <0-64> **priority**		Clears the Priority of the switch, enter the instance number.

i If you configure a priority of STP or RSTP in the switch, you should configure MSTP instance ID number as 0.

8.3.7.2 Path-cost

After deciding a root swich, you need to decide to which route you will forward the packet. To do this, the standard is a path-cost. By the path-cost of root port, you can configure a route manually. To configure the path-cost value for specified instance number in MSTP, use the following command.

Command	Mode	Description
spanning-tree mst <0-64> **port** *PORTS* **cost** <1-200000000>	Bridge	Configures path-cost for specified MSTP instance number: 0-64: MSTP instance ID number. 1-200000000: the path cost value.
no spanning-tree mst <0-64> **port** *PORTS* **cost**		Deletes a configured path-cost.

8.3.7.3 Port Priority

When all conditions of two routes of switch are same, the last standard to decide a route is port-priority. You can configure port priority and select a route manually.

To configure a port priority for MSTP instance, use the following command.

Command	Mode	Description
spanning-tree mst <0-64> **port** *PORTS* **port-priority** <0-240>	Bridge	Configures the port priority of MSTP instance. 0-64: MSTP instance ID number PORTS: port number 0-240: port priority in increments of 16 (default:128)
no spanning-tree mst <0-64> **port** *PORTS* **port-priority**		Deletes a configured port priority of MSTP instance.

8.3.7.4 MST Region

To set the configuration ID of MST region in detail, you need to open *MSTP Configuration* mode first. To open *MSTP Configuration* mode, use the following command.

Command	Mode	Description
spanning-tree mst configuation	Bridge	Opens *MSTP Configuration* mode.

After opening *MSTP Configuration* mode, the prompt changes from SWITCH(bridge)# to SWITCH(config-mst)#.

To delete all configations from *MSTP Configuration* mode, use the following command.

Command	Mode	Description
no spanning-tree mst configuation	Bridge	Deletes all configurations on *MSTP Configuration* mode, returns to the default values.

If MSTP is established in the switch, decide a MSTP region the switch is going to belong to by configuring the MST configuration ID. Configuration ID contains a region name, revision, and a VLAN map.

To set the configuration ID, use the following command on *MSTP Configuration* mode.

Command	Mode	Description
name *NAME*	MST-config	Sets the MSTP region name: NAME: the name of MSTP region.
instance <1-64> **vlan** *VLANS*		Maps the specified vlans to an MSTP instance: 1-64: select an instance ID number. VLANS: VLAN ID (1-4094)
revision <0-65535>		Specifies a revision number: 0-65535: the MSTP configuration revision number.

i In case of configuring STP and RSTP, you do not need to set the configuration ID. If you try to set configuration ID on STP or RSTP, an error message will be displayed.

i You can create the MSTP regions without limit on the network. But the instance id numbers of each region should not be over 64.

To delete the configuration ID setting, use the following command.

Command	Mode	Description
no name	MST-config	Deletes the name of MSTP region
no instance <1-64> **vlan** *VLANS*		Deletes part of vlan-mapping, select the instance ID number and vlan id to remove from the specified instance 1-64: instance ID number VLANS: VLAN ID (1-4094)
no revision		Deletes the configured revision number.

After configuring the configuration ID in the switch, you should apply the configuration to the switch. After changing or deleting the configuration, you must apply it to the switch. If not, it does not being reflected into the switch.

To apply the configuration to the system, use the following command.

Command	Mode	Description
apply	MST-config	Apllies the configuration of the region to the system.

i After deleting the configured configuration ID, apply it to the system using the above command.

To display the current and edited configuration on *MSTP Configuation* mode, use the following command.

Command	Mode	Description
show current	MSTP	Shows the current configuration as it is used to run MSTP
show pending		Shows the edited configuration of MSTP.
show		Shows all configurations of MSTP

For example, after setting the configuration ID, if you apply it to the switch with the **apply** command, you can check the configuration ID with the **show current** command.

However, if the user did not use the **apply** command to apply the configurations to the switch, the configuration could be checked with the **show pending** command.

8.3.7.5 Enabling MSTP configuration

To enable/disable a MSTP daemon by applying MSTP configurations to the system, use the following command.

Command	Mode	Description
spanning-tree mst	Bridge	Enables MSTP function on the system
no spanning-tree mst		Disables MSTP function on the system.

8.3.7.6 Displaying Configuration

To display the configuration of MSTP, use the following command.

Command	Mode	Description
show spanning-tree mst <1-64>	Enable Global Bridge	Shows all configurations of a specific MSTP instance: 1-64: MSTP instance ID number
show spanning-tree mst <1-64> **active** [**detail**]	Bridge	Shows information of a specific MSTP instance on active interface: 1-64: MSTP instance ID number. detail: detailed MSTP information (as option).
show spanning-tree mst <1-64> **blockedport**		Shows information of the blocked ports
show spanning-tree mst <1-64> **detail** [**active**]		Shows detailed information of the specific MSTP instance: 1-64: MSTP instance ID number.
show spanning-tree mst <1-64> **inconsistentports**		Shows information of root-inconsistency state. 1-64: MSTP instance ID number.
show spanning-tree mst <1-64> **bridge** [{ **address** | **detail** | **forward-time** | **hello-time** | **id** | **max-age** | **protocol** | **priority** [**system-id**] }]		Shows information of the bridge status and configuration of a specific MSTP instance 1-64: MSTP instance ID number.
show spanning-tree mst <1-64> **root** [{ **address** | **cost** | **detail** | **forward-time** | **hello-time** | **id** | **max-age** | **port** | **priority** [**system-id**] }]		Shows the status and configuration for the root bridge of a specifiec MSTP instance. 1-64: MSTP instance ID number.
show spanning-tree mst <1-64> **port** *PORTS* [{ **active** [**detail**] | **cost** | **detail** [**active**] | **edgeport** | **inconsistency** | **rootcost** | **state** | **priority** }]		Shows information of MSTP instance for specified port. 1-64: MSTP instance ID number.
show spanning-tree mst configuration [**digest**]		Shows information of the region configuration: digest: MD5 digest included in the current MSTCI
show spanning-tree mst <1-64> **summary** [**totals**]		Shows a summary of a specific MSTP instance: totals: the total lines of MSTP

8.3.8 Configuring PVSTP

STP and RSPT are designed with one VLAN in the network. If a port becomes blocking state, the physical port itself is blocked. But PVSTP (Per VLAN Spanning Tree Protocol) and PVRSTP (Per VLAN Rapid Spanning Tree Protocol) maintains spanning tree instance for each VLAN in the network. Because PVSTP treats each VLAN as a separate network, it has the ability to load balance traffic by forwarding some VLANs on one trunk and other VLANs. PVRSTP provides the same functionality as PVSTP with enhancement.

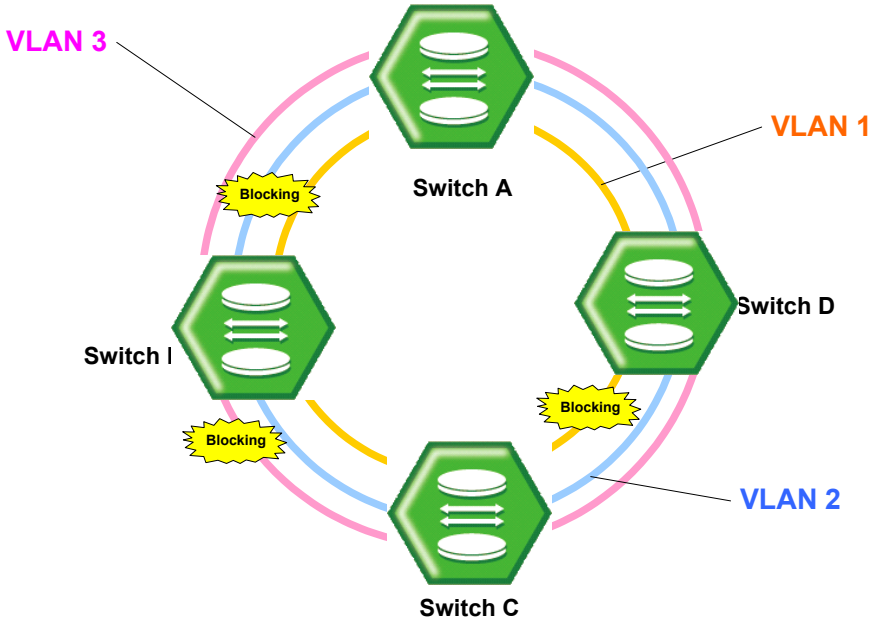


Fig. 8.25 Example of PVSTP

To configure PVSTP, use the following steps.

Step 1
Enable STP function using the **spanning-tree** command.

Step 2
Decide PVSTP mode using the **spanning-tree mode rapid-pvst** command.

Step 3
Enable PVSTP function using the **spanning-tree vlan** *VLANS* command.

Step 4
Configure detail options if specific commands are required.

8.3.8.1 Enabling PVSTP

To enable PVSTP function, use the following command.

Command	Mode	Description
spanning-tree vlan *VLANS*	Bridge	Activates PVSTP function. VLANS: VLAN ID (1-4094)

PVSTP is activated after selecting PVSTP mode using **spanning-tree mode rapid-pvst** command. In PVSTP, you can configure the current VLAN only. If you input VLAN that does not exist, error message is displayed.

For the switches in LAN where dual path doesn't exist, Loop does not generate even though STP function is not configured.

To disable a configured PVSTP, use the following command.

Command	Mode	Description
no spanning-tree vlan *VLANS*	Bridge	Disables PVSTP in VLAN. VLANS: VLAN ID (1-4094)

8.3.8.2 Root Switch

To establish PVSTP function, a root switch should be chosen first. Each switch has its own bridge ID, and one of the switchs on same LAN is chosen as a root switch by comparing with their bridge IDs. A bridge ID, consisting of the switch priority and the switch MAC address, is associated with each instance. However, you can configure the priority and make it more likely that the switch will be chosen as the root switch. The switch having the lowest priority becomes the root switch for that VLAN.

To configure the switch priority for a VLAN, use the following command.

Command	Mode	Description
spanning-tree vlan *VLANS* **priority** <0-61440>	Bridge	Configures a priority for specified VLAN. VLANS: VLAN ID (1-4094) 0-61440: priority value in increments of 4096 (default: 32768)
no spanning-tree vlan *VLANS* **priority**		Deletes a configured priority for specified VLAN.

8.3.8.3 Path-cost

After deciding Root switch, you need to decide to which route you will forward the packet. To do this, the standard is path-cost. Generally, path-cost depends on transmission speed of LAN interface in switch. In case the route is overload based on Path-cost, it is better to take another route.

By considering the situation, the user can configure Path-cost of Root port in order to designate the route on ones own.

To configure the path-cost value for specified vlan in PVSTP, use the following command.

Command	Mode	Description
spanning-tree vlan *VLANS* **port** *PORTS* **cost** <1-200000000>	Bridge	Configures path-cost to configure route on user's own. VLANS: VLAN ID (1-4094) PORTS: port number
no spanning-tree vlan *VLANS* **port** *PORTS* **cost**		Deleted a configured path-cost.

8.3.8.4 Port Priority

When all conditions of two routes of switch are same, the last standard to decide a route is port-priority. You can configure port priority and select a route manually.

To configure a port priority for specified VLAN, use the following command.

Command	Mode	Description
spanning-tree vlan *VLANS* **port** *PORTS* **port-priority** <0-240>	Bridge	Configures the port priority of specific VLAN. VLANS: VLAN ID (1-4094) 0-240: port priority in increments of 16 (default:128)
no spanning-tree vlan *VLANS* **port** *PORTS* **port-priority**		Deleted the configuration port priority of specifiec VLAN

8.3.8.5 Displaying Configuration

To display the configuration after configuring PVSTP, use the following command.

Command	Mode	Description
show spanning-tree vlan *VLANS*	Enable Global Bridge	Shows all configurations of a specific vlan id: VLANS: VLAN ID (1-4094)
show spanning-tree vlan *VLANS* **active** [**detail**]	Bridge	Shows information of a specific vlan id on active interface: detail: detailed PVSTP information (as option).
show spanning-tree vlan *VLANS* **blockedport**		Shows information of the blocked ports
show spanning-tree vlan *VLANS* **detail** [**active**]		Shows detailed information of the specific vlan id: VLANS: VLAN ID (1-4094)
show spanning-tree vlan *VLANS* **inconsistentports**		Shows information of root-inconsistency state. VLANS: VLAN ID (1-4094)
show spanning-tree vlan *VLANS* **bridge** [{ **address** | **detail** | **forward-time** | **hello-time** | **id** | **max-age** | **protocol** | **priority** [**system-id**] }]		Shows information of the bridge status and configuration of a specific vlan id VLANS: VLAN ID (1-4094)
show spanning-tree vlan *VLANS* **root** [{ **address** | **cost** | **detail** | **forward-time** | **hello-time** | **id** | **max-age** | **port** | **priority** [**system-id**] }]		Shows the status and configuration for the root bridge of a specifiec vlan id. VLANS: VLAN ID (1-4094)
show spanning-tree vlan *VLANS* **port** *PORTS* [{ **active** [**detail**] | **cost** | **detail** [**active**] | **edgeport** | **inconsistency** | **rootcost** | **state** | **priority** }]		Shows information of vlan id for specified port. VLANS: VLAN ID (1-4094)
show spanning-tree vlan *VLANS* **summary** [**totals**]		Shows a summary of a specific vlan id: totals: the total lines of PVSTP

8.3.9 Root Guard

The standard STP does not allow the administrator to enforce the position of the root bridge, as any bridge in the network with lower bridge ID will take the role of the root bridge. Root guard feature is designed to provide a way to enforce the root bridge placement in the network. Even if the administrator sets the root bridge priority to zero in an effort to secure the root bridge position, there is still no guarantee against bridge with priority zero and a lower MAC address.

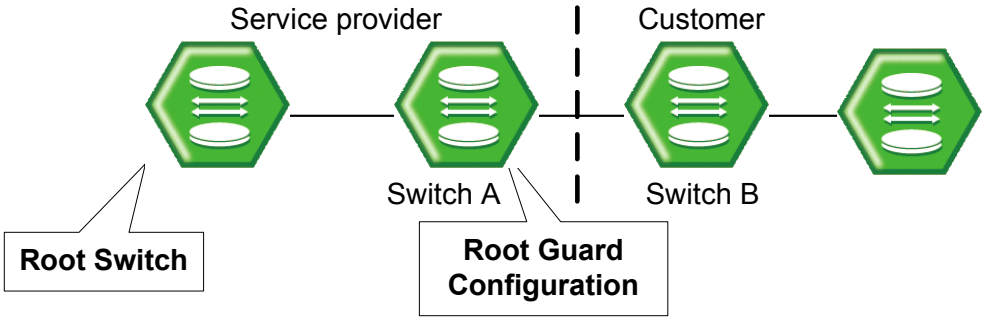


Fig. 8.26 Root Guard

Software-based bridge applications launched on PCs or other switches connected by a customer to a service-provider network can be elected as root switches. If the priority of bridge B is zero or any value lower than that of the root bridge, device B will be elected as a root bridge for this VLAN. As a result, network topology could be changed. This may lead to sub-optimal switching. But, by configuring root guard on switch A, no switches behind the port connecting to switch A can be elected as a root for the service provider's switch network. In which case, switch A will block the port connecting switch B.

To configure Root-Guard, use the following command.

Command	Mode	Description
spanning-tree port *PORTS* **guard root**	Bridge	Configures Root Guard on the network.

To delete a configured Root-Guard of specified port, use the following command.

Command	Mode	Description
spanning-tree port *PORTS* **guard none**	Bridge	Disables Root Guard function.
no spanning-tree port *PORTS* **guard**		Deletes a configured Root Guard, returns to default configurations.

8.3.10 Restarting Protocol Migration

MSTP protocol has a backward compatibility. MSTP is compatible with STP and RSTP. If some other bridge runs on STP mode and sends the BPDU version of STP or RSTP, MSTP automatically changes to STP mode. But STP mode cannot be changed to MSTP mode automatically. If administrator wants to change network topology to MSTP mode, administrator has to clear the previously detected detected protocol manually.

To prevent this, the switch provides the **clear spanning-tree detected-protocols** command. If you enable this command, the switch checks STP protocol packet once again.

To clear configured Restarting Protocol Migration, use the following command.

Command	Mode	Description
clear spanning-tree detected-protocols	Bridge	Restarts protocol migration function.
clear spanning-tree port *PORTS* **detected-protocols**		Restarts protocol migration function of specified port: PORTS: port number

8.3.11 Loop Back Detection

The problem occurs because the keepalive packet is looped back to the port that sent the keepalive. Keepalives are sent on the switches in order to prevent loops in the network. You see this problem on the device that detects and breaks the loop, but not on the device that causes the loop.

To enable error-disable detection for loop back cause, use the following command.

Command	Mode	Description
errdisable detect cause loopback	Bridge	Enables error-disable detection for loop back cause
no errdisable detect cause loopback		Disables error-disable detection for loop back cause

To display the status of error-disable cause, use the following command.

Command	Mode	Description
show errdisable detect cause	Bridge	Shows status of error-disable causes

To enable/disable the error-disable recovery function for loop back cause, use the following command.

Command	Mode	Description
errdisable recovery cause loopback	Bridge	Enables the recovery function for loop back error-disable cause
no errdisable recovery cause loopback		Disables the recovery function for loop back error-disable cause

To specify the time to recover from a specified error-disable cause, use the following command.

Command	Mode	Description
errdisable recovery interval <30-86400>	Bridge	Sets the interval of error-disable recovery: 30-86400: the recovery interval (default: 300 sec)
no errdisable recovery interval		Deleted the con figured time for error-disable recovery and returns to the default setting.

To display information of error-disable recovery function, use the following command.

Command	Mode	Description
show errdisable recovery	Bridge	Shows information of error-disable recovery function.

To enable/disable the debugging function of error-disable status caused by loop back, use the following command.

Command	Mode	Description
debug errdisable loopback enable	Enable	Enables the debugging for loop back error-disable cause.
debug errdisable loopback disable		Disables the debugging for loop back error-disable cause.

8.3.12 BPDU Configuration

BPDU is a transmission message in LAN in order to configure, and maintain the configuration for STP/RSTP/MSTP. Switches that STP is configured exchange their information BPDU to find the best path. MSTP BPDU is a general STP BPDU having additional MST data on its end. MSTP part of BPDU does not rest when it is out of region.

- **Hello Time**
  Hello time is an interval of which a switch transmits BPDU. It can be configured from 1 to 10 seconds. The default is 2 seconds.
- **Max Age**
  Root switch transmits new information every time based on information from other switches. However, if there are many switches on network, it takes lots of time to transmit BPDU. And if network status is changed while transmitting BPDU, this information is useless. To get rid of useless information, max age should be identified each information.
- **Forward Delay**
  Switches find the location of other switches connected to LAN though received BPDU and transmit packets. Since it takes certain time to receive BPDU and find the location before transmitting packet, switches send packet at regular interval. This interval time is named forward delay.

The configuration for BPDU is applied as selected in force-version. The same commands are used for STP, RSTP, MSTP and PVSTP.

8.3.12.1 Hello Time

Hello time decides an interval time when a switch transmits BPDU. To configure hello time, use the following command.

Command	Mode	Description
spanning-tree mst hello-time <1-10>	Bridge	Configures hello time to transmit the message in MSTP. 1-10: the hello time. (default: 2 sec)
spanning-tree vlan *VLANS* **hello-time** <1-10>		Configures hello time to transmit the message in PVSTP per VLAN. 1-10: the hello time. (default: 2 sec) VLANS: VLAN ID (1-4094)

To delete a configured hello-time, use the following command.

Command	Mode	Description
no spanning-tree mst hello-time	Bridge	Returns to the default hello time value of STP, RSTP and MSTP.
no spanning-tree vlan *VLANS* **hello-time**		Returns to the default hello time value of PVSTP.

8.3.12.2 Forward Delay Time

It is possible to configure forward delay, which means time to take port status from listening to forwarding. To configure forward delay, use the following command.

Command	Mode	Description
spanning-tree mst forward-time <4-30>	Bridge	Sets the forward-delay time for all MST instances: 4-30: forward delay time value (default:15)
spanning-tree vlan *VLANS* **forward-time** <4-30>		Sets the forward-delay time of PVSTP per VLAN: VLANS: VLAN ID (1-4094) 4-30: forward delay time value (default:15)

To delete a configured forward delay time, use the following command.

Command	Mode	Description
no spanning-tree mst forward-time	Bridge	Returns to the default value of MSTP.
no spanning-tree vlan *VLANS* **forward-time**		Returns to the default value of PVSTP per VLAN.

8.3.12.3 Max Age

Maximum aging time is the number of seconds a switch waits without receiving spanning-tree configuration messages before attempting a reconfiguration.

To configure the maximum aging time for deleting useless messages, use the following command.

Command	Mode	Description
spanning-tree mst max-age <6-40>	Bridge	Changes the maximum aging time of route message of MSTP. 6-40: maximum aging time value (default: 20 sec)
spanning-tree vlan *VLANS* **max-age** <6-40>		Changes the maximum aging time of route message of PVSTP per specified VLAN. VLANS: VLAN ID (1-4094) 6-40: maximum aging time value (default: 20 sec)

i We recommend that the maximum aging time is set less than twice of forward delay time and more than twice of hello time.

To delete a configured maximum aging time, use the following command.

Command	Mode	Description
no spanning-tree mst max-age	Bridge	Returns to the default maximum aging time value of MSTP.
no spanning-tree vlan *VLANS* **max-age**		Returns to the default maximum aging time value of PVSTP. VLANS: VLAN ID (1-4094)

8.3.12.4 BPDU Hop Count

In MSTP, it is possible to configure the number of hops in order to prevent BPDU from wandering. BPDU passes the switches as the number of hops by this function.

To configure the number of hops of BPDU in MSTP, use the following command.

Command	Mode	Description
spanning-tree mst max-hops <1-40>	Bridge	Configures the number of hops for BPDU, set the number of possible hops in MSTP region: 1-40: the number of hops for BPDU (default:20)
no spanning-tree mst max-hops		Deletes the number of hops for BPDU in MSTP.

8.3.12.5 BPDU Filtering

BPDU filtering allows you to avoid transmitting on the ports that are connected to an end system. If the BPDU Filter feature is enabled on the port, then incoming BPDUs will be filtered and BPDUs will not be sent out of the port.

To enable or disable the BPDU filtering function on the port, use the following command.

Command	Mode	Description
spanning-tree port *PORTS* **bpdufilter enable**	Bridge	Enables a BPDU filtering fuction on specific port.
spanning-tree port *PORTS* **bpdufilter disable**		Disables a BPDU filtering fuction on specific port.
no spanning-tree port *PORTS* **bpdufilter**		

By default, it is disabled. The BPDU filter-enabled port acts as if STP is disabled on the port. This feature can be used for the ports that are usually connected to an end system or the port that you don't want to receive and send unwanted BPDU packets. Be cautious about using this feature on STP enabled uplink or trunk port. If the port is removed from VLAN membership, correspond BPDU filter will be automatically deleted.

To enable or disable the BPDU filtering function on the edge port, use the following command.

Command	Mode	Description
spanning-tree edgeport bpdufilter default	Bridge	Enables a BPDU filtering function by default on all edge ports.
no spanning-tree edgeport bpdufilter default		Disables a BPDU filtering function by default on all edge ports.

8.3.12.6 BPDU Guard

BPDU guard has been designed to allow network designers to enforce the STP domain borders and keep the active topology predictable. The devices behind the ports with STP enabled are not allowed to influence the STP topology. This is achieved by disabling the port upon receipt of BPDU. This feature prevents Denial of Service (DoS) attack on the network by permanent STP recalculation. That is caused by the temporary introduction and subsequent removal of STP devices with low (zero) bridge priority.

To configure BPDU guard in the switch, perform the following procedure.

Step 1
Configure the specific port as edge-port.

Command	Mode	Description
spanning-tree port *PORTS* **edgeport enable**	Bridge	Configures the port as Edge port.

Step 2
Enable BPDU guard function on edge port or specific port, use the following command.

Command	Mode	Description
spanning-tree edgeport bpduguard default	Bridge	Enables BPDU Guard function on edge ports
spanning-tree port *PORTS* **bpduguard enable**		Enables BPDU Guard function on specified port

To disable BPDU guard function on edge port or specific port, use the following command.

Command	Mode	Description
no spanning-tree edgeport bpduguard default	Bridge	Disables BPDU Guard function of edge ports (default)
spanning-tree port *PORTS* **bpduguard disable**		Disables BPDU Guard function of specified port. (default)
no spanning-tree port *PORTS* **bpduguard**		

However, BPDU Guard can be corrupted by unexpected cause. In this case, the edge port is blocked immediately and remains at this state until user recovers it. To prevent this problem, the switch provides error-disable recovery function for BPDU guard cause. When an edge port is down for BPDU packet which came from other switch, the port is recovered automatically after configured time.

To enable the recovery function for BPDU guard error-disable cause, use the following command.

Command	Mode	Description
errdisable recovery cause bpduguard	Bridge	Enables the recovery function for BPDU guard error-disable cause
no errdisable recovery cause bpduguard		Disables the recovery function for BPDU guard error-disable cause

To display information of error-disable recovery function, use the following command.

Command	Mode	Description
show errdisable recovery	Bridge	Shows information of error-disable recovery function.

8.3.13 Sample Configuration

Backup Route

When you design layer 2 network, you must consider backup route for stable STP network. This is to prevent network corruption when just one additional path exits.

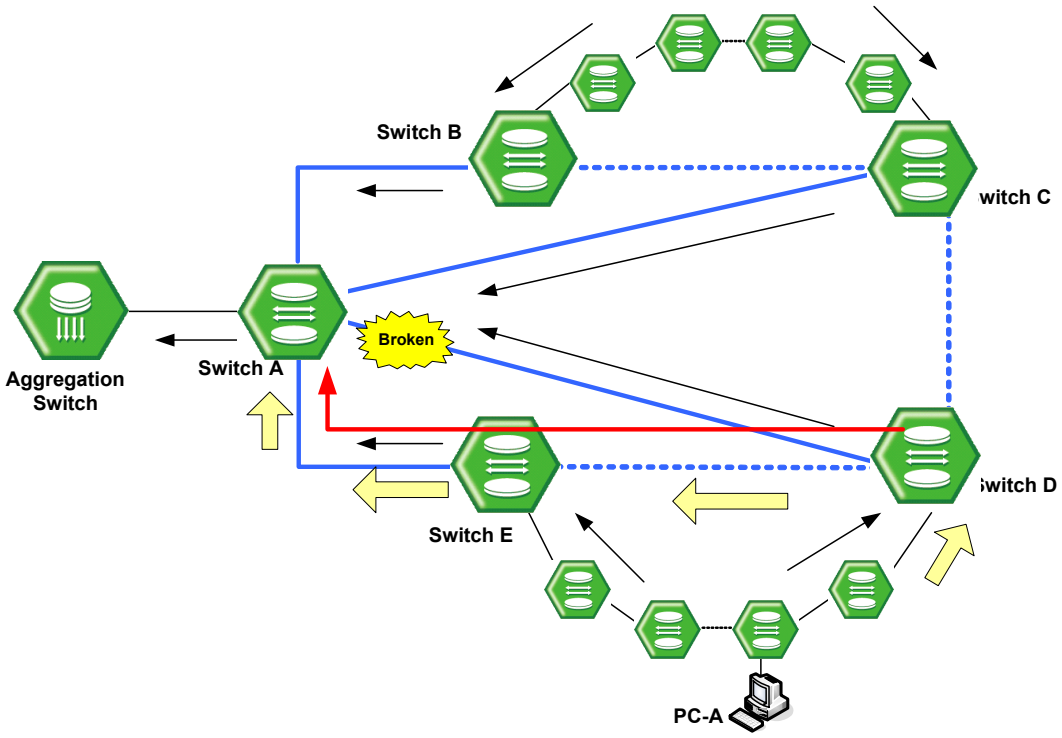


Fig. 8.27 Example of Layer 2 Network Design in RSTP Environment

In ordinary case, data packets go to Root switch A through the blue path. The black arrows describe the routine path to the Aggregation Switch. And the dot lines are in blocking state. But if there is a broken between Switch A and Switch B, the data from PC-A should find another route at Switch D. Switch D can send the data to Switch C and Switch E. Because Switch E has shorter hop count than Switch B, the data may go through the Switch E and A as the red line. And we can assume Switch E is also failed at the same time. In this case, since Switch D can has the other route to Switch C, the network can be stable than just one backup route network.

MSTP Configuration

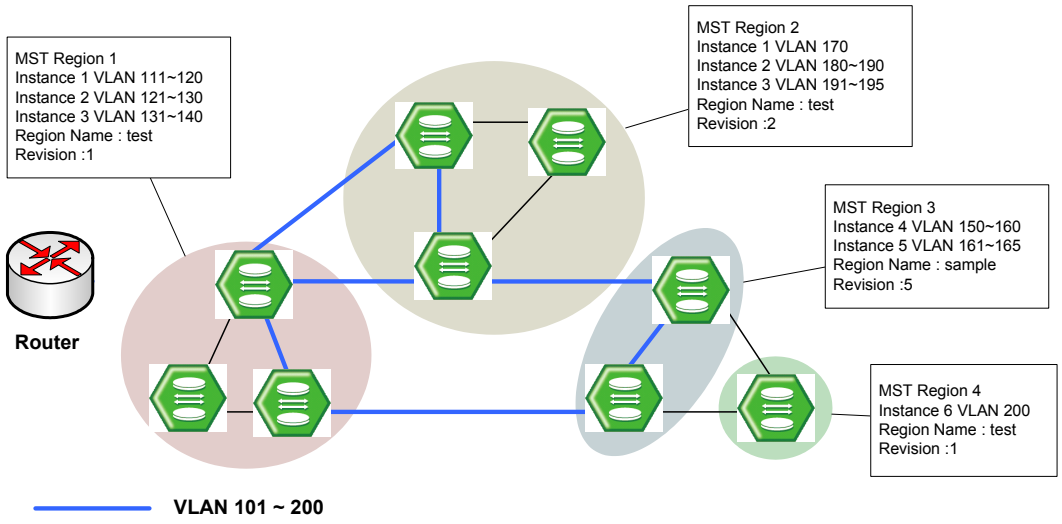


Fig. 8.28 Example of Layer 2 Network Design in MSTP Environment

The following is an example of configuring MSTP in the switch.

```
SWITCH(bridge)# spanning-tree
SWITCH(bridge)# spanning-tree mode mst
SWITCH(bridge)# spanning-tree mst configuration
SWITCH(config-mst)# instance 2 vlan 1-50
SWITCH(config-mst)# name test
SWITCH(config-mst)# revision 1
SWITCH(config-mst)# apply
SWITCH(config-mst)# exit
SWITCH(bridge)# show spanning-tree mst configuration

name                test
revision            1
instance vlans
-------------------------------------------------------------------
CIST      51-4094
  2       1-50
-------------------------------------------------------------------
SWITCH(bridge)#
```

8.4 Ethernet Ring Protection (ERP)

The ERP is a protection protocol for Ethernet ring topology to prevent Loop from a link failure or recovery. It is designed to minimize the time for removing Loop within 50 milliseconds while there is an enormous amount of traffic flow in Metro Ethernet network.

It is a unique robustness functionality, which runs on every network element involved in the ring configurations. It means that each system is active part of the ring protection mechanism. Therefore, it guarantees to switch over towards a new topology after link or system failure within 50 milliseconds.

8.4.1 ERP Mechanism

The purpose of Ethernet Ring Protection (ERP) is to prevent the Loop by performing the Redundancy Manager Node (RM Node) to detect a link failure and recover from it. An Ethernet ring consists of one or more ERP domains. ERP domain is an identifier of a single ring topology to be controlled by ERP mechanism. A node is one of the switches on the ERP ring. Each switch is configured as either RM node or normal node. RM node is responsible for keeping an open loop whenever all nodes and links are operating correctly. One ERP domain should have one RM node. Normal nodes are responsible to inform RM node of Link failures/recovery.

Both RM node and normal node have a primary and secondary port. You need to specify primary and secondary port which is directly connected to the node within an Ethernet ring. A secondary port of RM node is blocked as unused link for traffic while it runs without the link failure detection.

ERP Operation

If a link failure occurs, the normal nodes adjacent to the failure block their ports that detecting the link failure and send Link Down message to RM node. After RM node receives Link Down messages from the normal nodes, it unblocks its secondary port for traffic transmission. RM node responds to those messages using RM Link Down message which informs the other nodes that its secondary port has been unblocked.

If the link failure is recovered, the normal nodes send Link Up message to RM node. And they keep the blocking status of those failed ports. If the blocked ports of the normal nodes start to forward right after a Link Failure is recovered, a temporary loop can occur.

If RM node receives Link Up message, it blocks its own secondary port and sends RM Link UP message which informs the nodes of the secondary port's blocking status. If the nodes receive RM Link Up message, they unblocks the ports which are detected a Link Failure recovery. The Ethernet ring is back to normal state.

ERP Messages

There are five types of ERP messages of concern to the RM node-Normal node interaction in ERP ring as shown below:

- **Normal Node messages**
  The following messages are sent by the normal nodes to inform RM node of their link changes.
  – **Link Down**: A normal node sends Link Down messages detecting its link failure.
  – **Link Up**: A normal node sends Link Up messages detecting its link recovery.
- **RM Node messages**
  A RM node is in charge of protecting the Ethernet ring. It sends periodic Test Packet messages to normal nodes and receives Link Down/Up message from those nodes to detect the link failure or recovery.
  – **Test Packet (TP)**: This is used to determine if any loops occur in the Ethernet ring.
  – **RM Link Down**: This is used to inform the normal nodes of unblocking status of its secondary port caused by link failure.
  – **RM Link Up**: This is used to inform the normal nodes of re-blocking status of its secondary port caused by link recovery.

ERP implementation of the switch has the following restrictions, so you should keep in mind those before configuring ERP.

- ERP can not be configured with STP. If ERP is enabled in the system, STP is automatically disabled.
- A primary and secondary port number should not be same.
- ERP mechanism should be used for Ethernet Ring topology only.

If the link failure occurs, the nodes adjacent (Node A & B) to the failure detect their state and send Link Down message to RM node. If an intermediate node (Node C) between RM node and a node adjacent to link failure receives Link Down message, it starts to perform Forwarding Database (FDB) Flushing. FDB Flushing consists in erasing in the forwarding database of the switch all MAC entries of the protected VLANs that are forwarded to the ring ports. The Flushing of FDB is always followed by a period with learning disabled. To prevent wrong MAC learning due to the remaining packets in the buffer, a node does not learn MAC addresses during a configured learning disable time.

Fig. 8.29 shows an example of ERP operation when a link failure occurs.

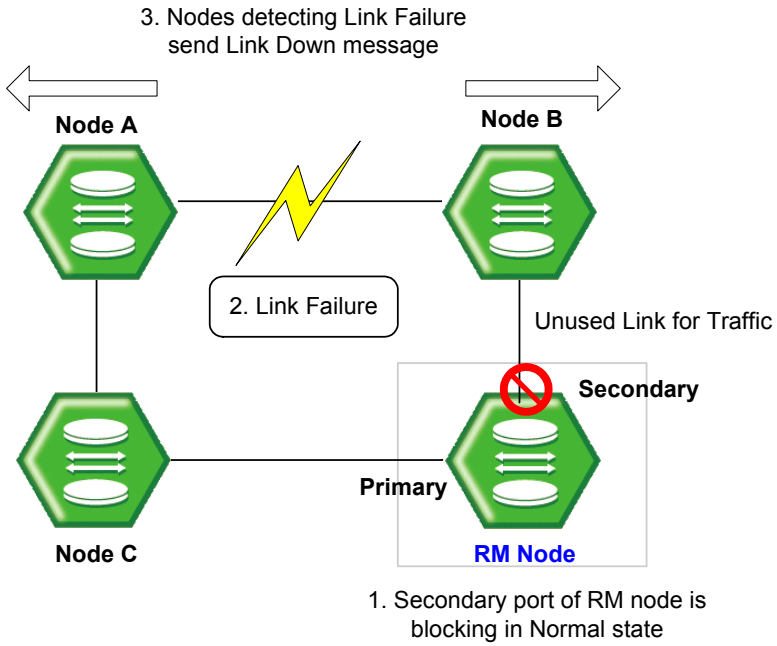


Fig. 8.29 ERP Operation in case of Linnk Failure

After RM node receives Link Down messages from other nodes, it unblocks its secondary port for traffic transmission with Node B directly connected to the secondary port. RM node sends RM Link Down messages and informs the other nodes that its secondary port begins forwarding the traffic.

Fig. 8.30 shows an example of a ring protection after a link failure.

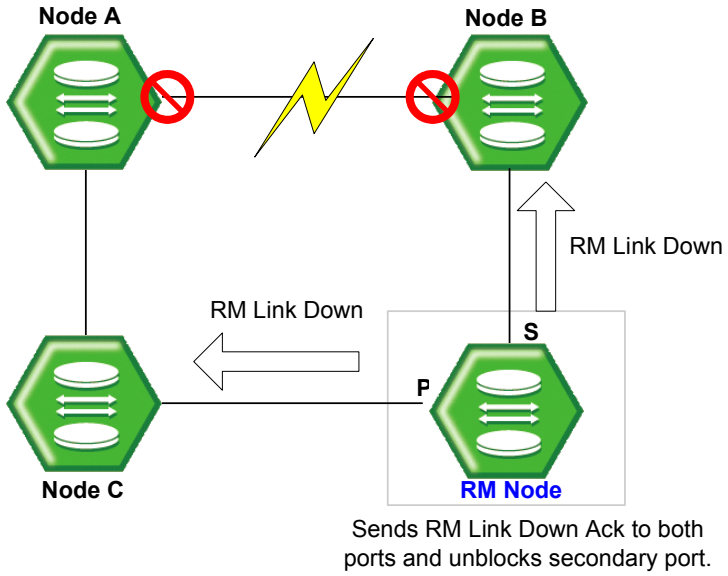


Fig. 8.30 Ring Protection

If Node A and Node B detect the link failure being recovered, they send Link Up message to RM node. But these nodes keep the blocking status of the link recovered ports.

Fig. 8.31 shows an example of a Link Failure Recovery operation.

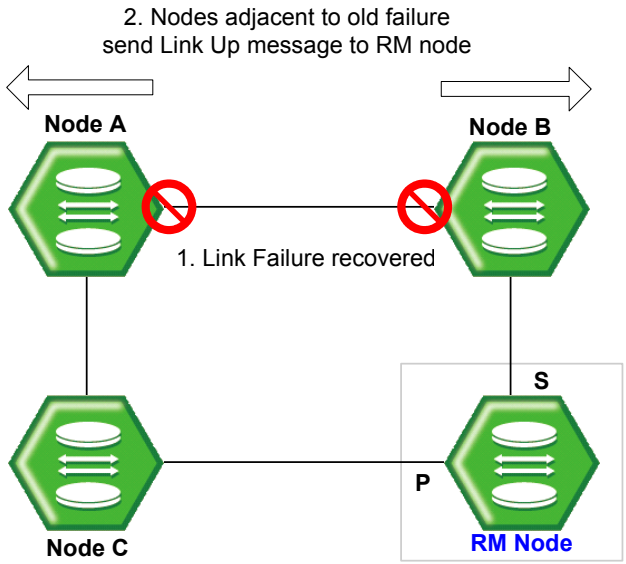


Fig. 8.31 Link Failure Recovery

After RM node receives Link Up message, it blocks its own secondary port. RM node sends RM Link UP message that informs other nodes the blocking status of secondary port. If the nodes receives RM Link Up message, they unblocks the ports which are detected a Link Failure recovery. The Ethernet ring is back to normal state.

Fig. 8.32 shows an example of a Ring Recovery operation.

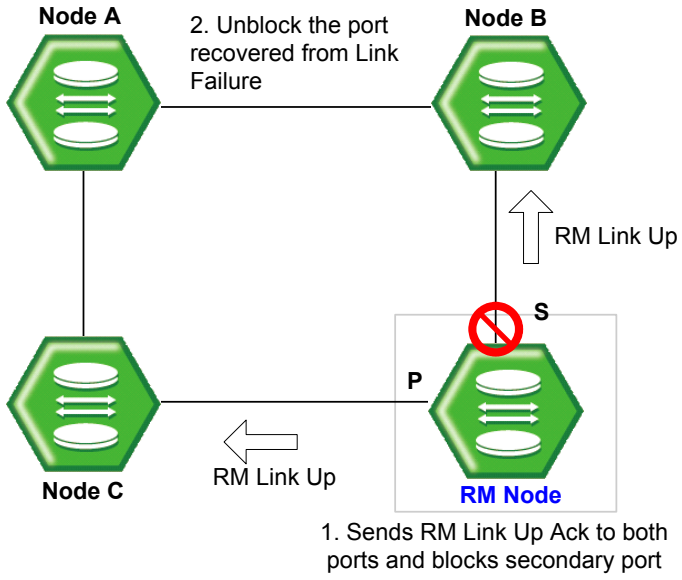


Fig. 8.32 Ring Recovery

8.4.2 Loss of Test Packet (LOTP)

ERP recognizes the Link Failure using Loss of Test Packet (LOTP) mechanism. RM Node periodically sends periodic “RM Test Packet” message. The state of LOTP means that “RM Test Packet” message does not return three consecutive times to RM node through Ethernet Ring. If RM node receives its “RM Test Packet” message through Ethernet Ring, it continues to block its secondary port.

You can configure the interval for sending “RM Test Packet” message.

8.4.3 ERP Shared Link

Sharing a link between two ERP rings allows the two nodes adjacent to the link to be common to the two rings. Sharing one link between two rings would create a “super loop” if that link failed. To prevent the super loop, two ERP domains should have different priorities. This concept is called “ERP ring priority.” When a link is shared by two or more rings, one RM node with the highest priority is responsible to protect failures of the shared link. Two normal nodes of a shared link belong to both ERP domains. The control packets (TPs) can be transmitted from the lower priority domain to higher priority domain only.

Fig. 8.33 shows the example of ring interconnection using one shared link.

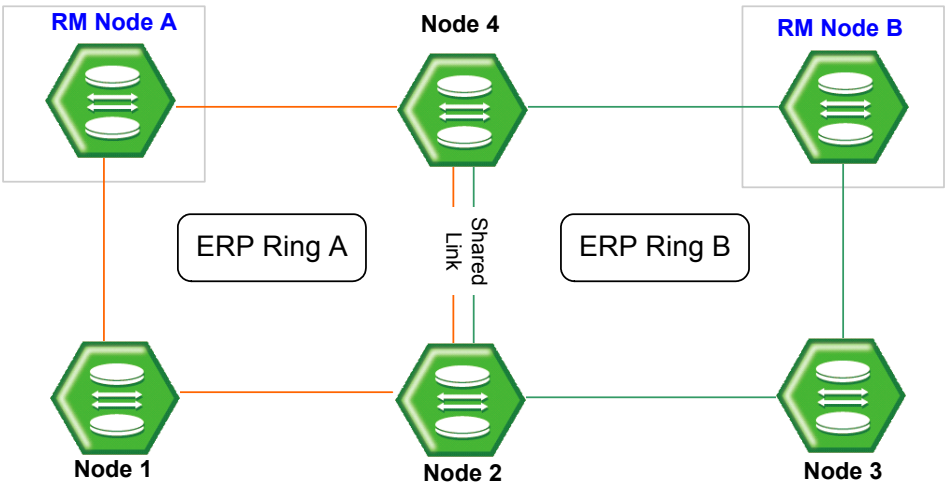


Fig. 8.33 Shared Link

ERP shared link environment has the following requirements, so you should keep in mind them before configuring ERP ring topology with a shared link.

- A port adjacent to the shared link should not be blocked. It means that a shared link that is used as the one of the secondary ports of a RM node.
- If there are two ERP domains with a single shared link, you should specify different priority of ERP domains.
- The higher priority domain should include all protected and control VLANs of the lower priority domain to protect and manage the lower priority ring more effectively.

8.4.4 Configuring ERP Domain

To realize ERP, you should fist create domain for ERP. To create the domain, use the following command.

Command	Mode	Description
erp domain *DOMAIN-ID*	Bridge	Creates ERP domain and opens ERP domain configuration mode. DOMAIN-ID: <1-64>
no erp domain *DOMAIN-ID*		Deletes ERP domain.

8.4.4.1 ERP Domain Name

After ERP domain creation, you can specify its name, To specifiy ERP domain name, use the following command.

Command	Mode	Description
name *NAME*	ERP Domain	Configures ERP domain name.
no name		Deletes the configured ERP domain name.

8.4.4.2 Primary and Secondary Port

To configure Primary Port and Secondary port of a specific domain ID, use the following command.

Command	Mode	Description
primary-port *PORT*	ERP Domain	Configures primary port of an ERP domain
secondary-port *PORT*		Configures secondary port of an ERP domain

i Primary port and secondary port should be different.

To delete ERP domain ID's primary or secondary port, use the following command.

Command	Mode	Description
no primary-port	ERP Domain	Deletes primary port of an ERP domain
no secondary-port		Deletes secondary port of an ERP domain

8.4.4.3 Protected VLAN

ERP enabled switches within same ring send/receive data packets to/from each other using their protected VLAN.

To configure a protected VLAN of an ERP domain, use the following command.

Command	Mode	Description
protected-vlan *VLAN*	ERP Domain	Configures a protected VLAN of ERP domain.
no protected-vlan [*VLAN*]		Deletes configured protected VLAN of ERP domain

8.4.4.4 Control VLAN

RM Node periodically sends “RM Test Packet” message to detect the loop. RM Test packet message can be transmiited by control VLAN only. Each ERP domain should have one control VLAN.

To configure a control VLAN of an ERP domain, use the following command.

Command	Mode	Description
control-vlan *VLAN*	ERP Domain	Configures a control VLAN of ERP domain.
no control-vlan		Deletes configured control VLAN of ERP domain

8.4.4.5 ERP Ring Priority

The Super Loop occurs because of a shared link’s failure between two ERP rings. A domain with higher priority (one of the RM nodes) is the only responsible for monitoring the ports of a shared link. The control packets of a domain with lower ring priority can be transmitted to another domain with higher priority to prevent the super loop.

It means that the higher ring priority domain guarantees the detour path against a shared link of lower ring priority domain.

To specify ERP ring priority, use the following command.

Command	Mode	Description
ring-priority <1-255>	ERP Domain	Specifies ERP ring priority 1-255: ERP ring priority value (default: 0)

To return ERP ring priority as default, use the following command.

Command	Mode	Description
no ring-priority	ERP Domain	Configures ERP ring priority as default value

8.4.4.6 Displaying ERP Domian

To display a configuration for specific ERP domain, use the following command.

Command	Mode	Description
show pending	ERP Domain	Shows modified configurations of ERP domain.
show current		Shows updated configuration of ERP domain.
show		Shows all of configuration of ERP domain.

8.4.5 Selecting the Node

To configure an ERP domain as RM Node, use the following command.

Command	Mode	Description
erp domain *DOMAIN-ID* **mode rm**	Bridge	Configures ERP node mode as RM node.

To configure an ERP domain as normal node, use the following command.

Command	Mode	Description
erp domain *DOMAIN-ID* **mode normal**	Bridge	Configures ERP node mode as normal node.

8.4.6 Protected Activation

When you finish configuring specific ERP domain with Domain ID, domain name, primary port and secondary port, you should activate the ERP domain to apply to the system. To activate an ERP domain, use the following command.

Command	Mode	Description
erp domain *DOMAIN-ID* **activation activate**	Bridge	Configures ERP Protected Activation.

To deactivate an ERP domain, use the following command.

Command	Mode	Description
no erp domain *DOMAIN-ID* **activation**	Bridge	Deactivates an ERP domain. (default)
erp domain *DOMAIN-ID* **activation deactivate**		

8.4.7 Manual Switch to Secondary

A secondary port is supposed to be blocked as unused link for traffic while ERP runs without any link failure. While a primary port forwards the traffic to other nodes. But you can configure a primary port to be blocked as a secondary port role. A secondary port is automatically changed to forward the traffic.

To manually configure a primary or secondary port as an unused link that should be blocked for traffic in normal condition of Ethernet ring, use the following command.

Command	Mode	Description
erp domain *DOMAIN-ID* **manual-switch primary**	Bridge	Unblocks a primary port and blocks a secondary port of ERP domain as RM node (default)
erp domain *DOMAIN-ID* **manual-switch secondary**		Blocks a primary port and unblocks a secondary port of ERP domain as RM node.

To delete the configuration of primay/secondary port's role change, use the following command.

Command	Mode	Description
no erp domain *DOMAIN-ID* **manual-switch**	Bridge	Deletes the configured primary and secondary port state

8.4.8 Wait-to-Restore Time

If a port's link failure is recovered on the normal node, the blocked port should be changed to the forwarding status. However, the loop may occur when this port start to forward the traffic before a secondary port of RM node is blocked. To prevent the loop, the normal node waits for the time until it receives RM Link Up message. Even if it does not receive RM Link Up message, the port starts to forward the traffic.

i The normal node waits for real waiting timeout to forward the traffic again. The formula is simply shown as below:

Real Waiting timeout = Wait-to-Restore Time + 3Test Packet Interval
e.g. 1.3 seconds = 1 second + (10 milliseconds x 3)

To configure Wait-to-Restore Time, use the following command.

Command	Mode	Description
erp domain *DOMAIN-ID* **wait-to-restore** <1-720>	Bridge	Configures ERP wait-to-restore time. 1-720: Wait to restore time in second

To return the configured Wait-to-Restore Time as Default, use the following command.

Command	Mode	Description
no erp domain *DOMAIN-ID* **wait-to-restore**	Bridge	Configures ERP wait-to-restore time as default value.

8.4.9 Learning Disable Time

To prevent wrong MAC learning due to the remaining packets of buffer, a node does not learn MAC addresses during the learning disable time. This parameter holds the time, in milliseconds, during which learning is disabled after FDB flushing and can be configured by the operator. The learning is only disabled for the protected VLAN of the domain on the ERP ports.

To configure a Learning Disable Time, use the following command.

Command	Mode	Description
erp domain *DOMAIN-ID* **learning-disable-time** <0-500>	Bridge	Configures ERP learning disable time. 0-500: learning disabling time (unit: millisecond)

To return the configured learning disable time as default, use the following command.

Command	Mode	Description
no erp domain *DOMAIN-ID* **learning-disable-time**	Bridge	Configures ERP learning disable time as default value.

8.4.10 Test Packet Interval

RM Node periodically sends “RM Test Packet” message to detect the loop. To configure an interval to send Test Packet message of RM node, use the following command.

Command	Mode	Description
erp domain *DOMAIN-ID* **test-packet-interval** <10-500>	Bridge	Specifies the interval of ERP test packet. 10-500: packet interval (unit: millisecond)

To delete the specified interval of ERP test packet interval, use the following command.

Command	Mode	Description
no erp domain *DOMAIN-ID* **test-packet-interval**	Bridge	Deletes the specified interval of ERP test packet.

8.4.11 LOTP Hold Off Time

It is necessary to prevent lower priority rings to trigger protection because of loss of test packets before the protection of the higher priority ring and transmission of test packets over this ring.

LOTP hold-off time determines the hold-off time for ERP switching in case of detection of LOTP. This parameter provides independence between ERP rings. Hold-off time for LOTP triggered ERP delays ERP switching if a ring protection of this domain is also provided by other higher priority rings. LOTP Hold-Off Time value depends on the ring priority of ERP rings.

To specify LOTP hold-off time, use the following command.

Command	Mode	Description
erp domain *DOMAIN-ID* **hold-off-time** <1-20000>	Bridge	Configures LOTP hold-off time 1-20000: ERP hold-off time (default: 0 ms, unit: millisecond)

To configure LOTP hold-off time as default, use the following command.

Command	Mode	Description
no erp domain *DOMAIN-ID* **hold-off-time**	Bridge	Configures LOTP hold-off time as default value

8.4.12 ERP Trap

To enable the system to generate ERP trap message, use the following command.

Command	Mode	Description
erp domain *DOMAIN-ID* **trap** {**lotp** | **ulotp** | **multiple-rm** | **rmnode-reachability**}	Bridge	Enables the system to send ERP Trap message in case of the event.

To disable the system to generate ERP trap message, use the following command.

Command	Mode	Description
no erp domain *DOMAIN-ID* **trap** {**lotp** | **ulotp** | **multiple-rm** | **rmnode-reachability**}	Bridge	Disables the system to generate ERP trap

The following options hold the configuration of the ability to transmit LOTP, ULOTP, Multiple RM or RMNode reachability Traps.

– **lotp**: Enables/disables an RM node to transmit the LOTP traps.
– **ulotp**: Enables/disables an RM node to transmit the ULOTP (Undirectional Loss Of Test Packets) traps.
– **multiple-rm**: Enables/disables an RM node to transmit the trap in case of Multiple RM nodes.
– **rmnode-reachability**: Enables/disables a normal node to transmit RMnode Reachablility traps.

8.4.13 Displaying ERP Configuration

To display a configuration of ERP, use the following command.

Command	Mode	Description
show erp [**domain** <1-64>]	Enable Global Bridge	Shows the information of ERP 1-64: domain ID
show erp state		

8.5 Loop Detection

The loop may occur when double paths are used for the link redundancy between switches and one sends unknown unicast or multicast packet that causes endless packet floating on the LAN like loop topology. That superfluous traffic eventually can result in network fault. It causes superfluous data transmission and network fault.

To prevent this, the switch provides the loop detecting function. The loop detecting mechanism is as follows:

The switch periodically sends the loop-detecting packet to all the ports with a certain interval, and then if receiving the loop-detecting packet sent before, the switch performs a pre-defined behavior.

To enable/disable the loop detection globally, use the following command.

Command	Mode	Description
loop-detect {**enable** | **disable**}	Bridge	Enables/disables the loop detection globally.

i For the detailed configuration of the loop detection, you need to issuing the **loop-detect enable** command first. If you do not, all the commands concerning the loop detection will show an error message.

To enable/disable the loop detection on a specified port, use the following command.

Command	Mode	Description
loop-detect *PORTS*	Bridge	Enables the loop detection on a specified port.
no loop-detect *PORTS*		Disables the loop detection on a specified port.

To define the behavior on a specified port when a loop is occurred, use the following command.

Command	Mode	Description
loop-detect *PORT* **block**	Bridge	Enables the blocking option. This configures a specified port to automatically change its state to BLOCKED when a loop is detected on it. (default: disable)
loop-detect *PORT* **unblock**		Forces the state of a blocked port to change to NORMAL.
loop-detect *PORT* **timer** <0-86400>		Sets the interval of changing the state of a blocked port to NORMAL. If you set the interval as 0, the state of the blocked port will not be changed automatically. (default: 600 seconds)
no loop-detect *PORT* **block**		Disables the blocking option.

To set the interval of sending the loop-detecting packet, use the following command.

Command	Mode	Description
loop-detect *PORTS* **period** <1-60>	Bridge	Sets the interval of sending the loop-detecting packet. (default: 30 seconds)

You can also configure the source MAC address of the loop-detecting packet. Normally the system's MAC address will be the source MAC address of the loop-detecting packet, but if needed, Locally Administered Address (LAA) can be the address as well.

If the switch is configured to use LAA as the source MAC address of the loop-detecting packet, the second bit of first byte of the packet will be set to 1. For example, if the switch's MAC address is 00:d0:cb:00:00:01, the source MAC address will be changed to 02:d0:cb:00:00:01.

To select the source MAC address type of the loop-detecting packet, use the following command.

Command	Mode	Description
loop-detect srcmac laa	Bridge	Uses LAA as the source MAC address of the loop-detecting packet.
loop-detect srcmac system		Uses the system's MAC address as the source MAC address of the loop-detecting packet. (default)

If you would like to change the source MAC address of the loop-detecting packet, you should disable the loop detection first using the **loop-detect disable** command.

To display a current configuration of the loop detection, use the following command.

Command	Mode	Description
show loop-detect	Enable Global Bridge	Shows the brief information of the loop detection.
show loop-detect {**all** | *PORTS*}		Shows a current configuration of the loop detection per port.

The loop detection cannot operate with LACP.

8.6 Dynamic Host Configuration Protocol (DHCP)

Dynamic Host Configuration Protocol (DHCP) is a TCP/IP standard for simplifying the administrative management of IP address configuration by automating address configuration for network clients. The DHCP standard provides for the use of DHCP servers as a way to manage dynamic allocation of IP addresses and other relevant configuration details to DHCP-enabled clients on the network.

Every device on a TCP/IP network must have a unique IP address in order to access the network and its resources. The IP address (together with its relevant subnet mask) identifies both the host computer and the subnet to which it is attached. When you move a computer to a different subnet, the IP address must be changed. DHCP allows you to dynamically assign an IP address to a client from a DHCP server IP address database on the local network.

The DHCP provides the following benefits:

Saving Cost

Numerous users can access the IP network with a small amount of IP resources in the environment that most users do not have to access the IP network at the same time all day long. This allows the network administrators to save the cost and IP resources.

Efficient IP Management

By deploying DHCP in a network, this entire process is automated and centrally managed. The DHCP server maintains a pool of IP addresses and leases an address to any DHCP-enabled client when it logs on to the network. Because the IP addresses are dynamic (leased) rather than static (permanently assigned), addresses no longer in use are automatically returned to the pool for reallocation.

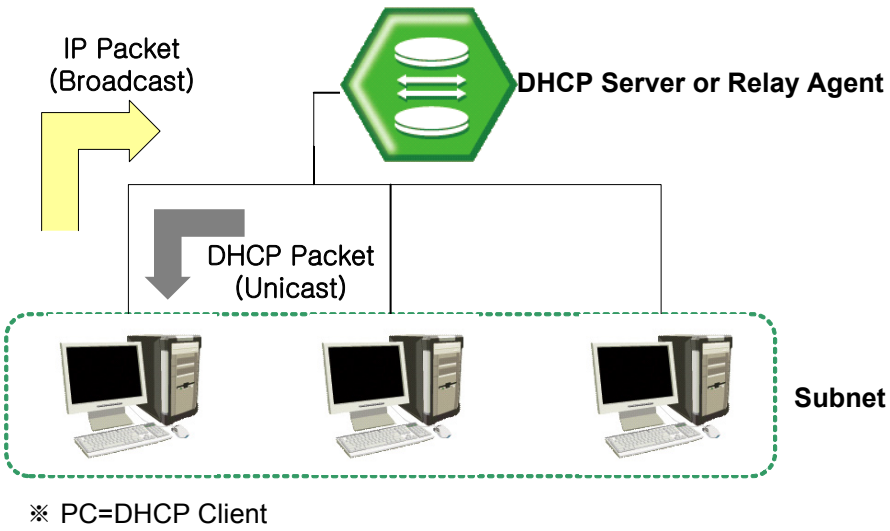


Fig. 8.34 DHCP Service Structure

The switch flexibly provides the functions as the DHCP server or DHCP relay agent according to your DHCP configuration.

This chapter contains the following sections:

- DHCP Server
- DHCP Address Allocation with Option 82
- DHCP Lease Database
- DHCP Relay Agent
- DHCP Option 82
- DHCP Snooping
- IP Source Guard
- DHCP Client
- DHCP Filtering
- Debugging DHCP

8.6.1 DHCP Server

This section describes the following DHCP server-related features and configurations:

- DHCP Pool Creation
- DHCP Subnet
- Range of IP Address
- Default Gateway
- IP Lease Time
- DNS Server
- Manual Binding
- Domain Name
- DHCP Server Option
- Static Mapping
- Recognition of DHCP Client
- IP Address Validation
- Authorized ARP
- Prohibition of 1:N IP Address Assignment
- Ignoring BOOTP Request
- DHCP Packet Statistics
- Setting DHCP Pool Size
- Displaying DHCP Pool Configuration

To activate/deactivate the DHCP function in the system, use the following command.

Command	Mode	Description
service dhcp	Global	Activates the DHCP function in the system.
no service dhcp		Deactivates the DHCP function in the system.

Before configuring DHCP server or relay, you need to use the **service dhcp** command first to activate the DHCP function in the system.

8.6.1.1 DHCP Pool Creation

The DHCP pool is a group of IP addresses that will be assigned to DHCP clients by DHCP server. You can create various DHCP pools that can be configured with a different network, default gateway and range of IP addresses. This allows the network administrators to effectively handle multiple DHCP environments.

To create a DHCP pool, use the following command.

Command	Mode	Description
ip dhcp pool *POOL*	Global	Creates a DHCP pool and opens *DHCP Pool Configuration* mode.
no ip dhcp pool *POOL*		Deletes a created DHCP pool.

The following is an example of creating the DHCP pool as *sample*.

```
SWITCH(config)# service dhcp
SWITCH(config)# ip dhcp pool sample
SWITCH(config-dhcp[sample])#
```

8.6.1.2 DHCP Subnet

To specify a subnet of the DHCP pool, use the following command.

Command	Mode	Description
network *A.B.C.D/M*	DHCP Pool	Specifies a subnet of the DHCP pool. A.B.C.D/M: network address
no network *A.B.C.D/M*		Deletes a specified subnet.

The following is an example of specifying the subnet as 100.1.1.0/24.

```
SWITCH(config)# service dhcp
SWITCH(config)# ip dhcp pool sample
SWITCH(config-dhcp[sample])# network 100.1.1.0/24
SWITCH(config-dhcp[sample])#
```

You can also specify several subnets in a single DHCP pool.

8.6.1.3 Range of IP Address

To specify a range of IP addresses that will be assigned to DHCP clients, use the following command.

Command	Mode	Description
range *A.B.C.D A.B.C.D*	DHCP Pool	Specifies a range of IP addresses. A.B.C.D: start/end IP address
no range *A.B.C.D A.B.C.D*		Deletes a specified range of IP addresses.

The following is an example for specifying the range of IP addresses.

```
SWITCH(config)# service dhcp
SWITCH(config)# ip dhcp pool sample
SWITCH(config-dhcp[sample])# network 100.1.1.0/24
SWITCH(config-dhcp[sample])# default-router 100.1.1.254
SWITCH(config-dhcp[sample])# range 100.1.1.1 100.1.1.100
SWITCH(config-dhcp[sample])#
```

You can also specify several inconsecutive ranges of IP addresses in a single DHCP pool, e.g. 100.1.1.1 to 100.1.1.62 and 100.1.1.129 to 100.1.1.190.

When specifying a range of IP address, the start IP address must be prior to the end IP address.

8.6.1.4 Default Gateway

To specify a default gateway of the DHCP pool, use the following command.

Command	Mode	Description
default-router *A.B.C.D1* [*A.B.C.D2*] … [*A.B.C.D8*]	DHCP Pool	Specifies a default gateway of the DHCP pool. A.B.C.D: default gateway IP address
no default-router *A.B.C.D1* [*A.B.C.D2*] … [*A.B.C.D8*]		Deletes a specified default gateway.
no default-router all		Deletes all the specified default gateways.

The following is an example of specifying the default gateway 100.1.1.254.

```
SWITCH(config)# service dhcp
SWITCH(config)# ip dhcp pool sample
SWITCH(config-dhcp[sample])# network 100.1.1.0/24
SWITCH(config-dhcp[sample])# default-router 100.1.1.254
SWITCH(config-dhcp[sample])#
```

8.6.1.5 IP Lease Time

Basically, the DHCP server leases an IP address in the DHCP pool to DHCP clients, which will be automatically returned to the DHCP pool when it is no longer in use or expired by IP lease time.

To specify IP lease time, use the following command.

Command	Mode	Description
lease-time default <120-2147483637>	DHCP Pool	Sets default IP lease time in the unit of second. (default: 3600)
lease-time max <120-2147483637>		Sets maximum IP lease time in the unit of second. (default: 3600)
no lease-time {**default** | **max**}		Deletes specified IP lease time.

The following is an example of setting default and maximum IP lease time.

```
SWITCH(config)# service dhcp
SWITCH(config)# ip dhcp pool sample
SWITCH(config-dhcp[sample])# network 100.1.1.0/24
SWITCH(config-dhcp[sample])# default-router 100.1.1.254
SWITCH(config-dhcp[sample])# range 100.1.1.1 100.1.1.100
SWITCH(config-dhcp[sample])# lease-time default 5000
SWITCH(config-dhcp[sample])# lease-time max 10000
SWITCH(config-dhcp[sample])#
```

8.6.1.6 DNS Server

To specify a DNS server to inform DHCP clients, use the following command.

Command	Mode	Description
dns-server *A.B.C.D1* [*A.B.C.D2*] … [*A.B.C.D8*]	DHCP Pool	Specifies a DNS server. Up to 8 DNS servers are possible. A.B.C.D: DNS server IP address
no dns-server *A.B.C.D1* [*A.B.C.D2*] … [*A.B.C.D8*]		Deletes a specified DNS server.
no dns-server all		Deletes all the specified DNS servers.

The following is an example of specifying a DNS server.

```
SWITCH(config)# service dhcp
SWITCH(config)# ip dhcp pool sample
SWITCH(config-dhcp[sample])# network 100.1.1.0/24
SWITCH(config-dhcp[sample])# default-router 100.1.1.254
SWITCH(config-dhcp[sample])# range 100.1.1.1 100.1.1.100
SWITCH(config-dhcp[sample])# lease-time default 5000
SWITCH(config-dhcp[sample])# lease-time max 10000
SWITCH(config-dhcp[sample])# dns-server 200.1.1.1 200.1.1.2 200.1.1.3
SWITCH(config-dhcp[sample])#
```

If you want to specify a DNS server for all the DHCP pools, use the **dns server** command. For more information, see Section 6.1.8.

8.6.1.7 Manual Binding

To manually assign a static IP address to a DHCP client who has a specified MAC address, use the following command.

Command	Mode	Description
fixed-address *A.B.C.D MAC-ADDRESS*	DHCP Pool	Assigns a static IP address to a DHCP client. A.B.C.D: static IP address MAC-ADDRESS: MAC address
no fixed-address *A.B.C.D*		Deletes a specified static IP assignment.

8.6.1.8 Domain Name

To set a domain name, use the following command.

Command	Mode	Description
domain-name *DOMAIN*	DHCP Pool	Sets a domain name.
no domain-name		Deletes a specified domain name.

8.6.1.9 DHCP Server Option

The switch operating DHCP server can include DHCP option information in the DHCP communication. Before using this function, a global DHCP option format should be created. For details of setting the DHCP option format, refer to the 8.6.5 DHCP Option.

To specify a DHCP server option, use the following command.

Command	Mode	Description
option code <1-254> **format** *NAME*	DHCP Pool	Specifies a DHCP option format for a DHCP server. code: DHCP option code NAME: DHCP option format name
no option code <1-254> **format**		Removes a specified DHCP option for a DHCP server.

DHCP server may not have any DHCP option that is configured in the DHCP pool mode. Then DHCP server finds the DHCP default option. If it exists, DHCP server sends DHCP clients a DHCP reply packet (Offer/ACK) with the default option information.

To specify a DHCP server default option, use the following command.

Command	Mode	Description
ip dhcp default-option code <1-254> **format** *NAME*	Global	Specifies a DHCP default option format for a DHCP server. code: DHCP option code NAME: DHCP option format name
no ip dhcp default-option code <1-254>		Removes a specified DHCP default option for a DHCP server.

8.6.1.10 Static Mapping

The switch provides a static mapping function that enables to assign a static IP address without manually specifying static IP assignment by using a DHCP lease database in the DHCP database agent.

To perform a static mapping, use the following command.

Command	Mode	Description
origin file *A.B.C.D FILE*	DHCP Pool	Performs a static mapping. A.B.C.D: DHCP database agent address FILE: file name of DHCP lease database
no origin file		Cancels a static mapping.

For more information of the file naming of a DHCP lease database, see Section 8.6.3.1.

8.6.1.11 Recognition of DHCP Client

Normally, a DHCP server recognizes DHCP clients with a client ID. However, some DHCP clients may not have their own client ID. In this case, you can select the recognition method as a hardware address instead of a client ID.

To select a recognition method of DHCP clients, use the following command.

Command	Mode	Description
ip dhcp database-key {**client-id** | **hardware-address**}	Global	Selects a recognition method of DHCP clients

8.6.1.12 IP Address Validation

Before assigning an IP address to a DHCP client, a DHCP server will validate if the IP address is used by another DHCP client with a ping or ARP. If the IP address does not respond to a requested ping or ARP, the DHCP server will realize that the IP address is not used then will assign the IP address to the DHCP client.

To select an IP address validation method, use the following command.

Command	Mode	Description
ip dhcp validate {**arp** | **ping**}	Global	Selects an IP address validation method.

You can also set a validation value of how many responses and how long waiting (timeout) for the responses from an IP address for a requested ping or ARP when a DHCP server validates an IP address.

To set a validation value of how many responses from an IP address for a requested ping or ARP, use the following command.

Command	Mode	Description
ip dhcp {**arp** | **ping**} **packet** <0-20>	Global	Sets a validation value of how many responses. 0-20: response value (default: 2)

To set a validation value of timeout for the responses from an IP address for a requested ping or ARP, use the following command.

Command	Mode	Description
ip dhcp {**arp** | **ping**} **timeout** <100-5000>	Global	Sets a validation value of timeout for the responses in the unit of millisecond. 100-5000: timeout value (default: 500)

8.6.1.13 Authorized ARP

The authorized ARP is to limit the lease of IP addresses to authorized users. This feature enables a DHCP server to add ARP entries only for the IP addresses currently in lease referring to a DHCP lease table, discarding ARP responses from unauthorized users (e.g. an illegal use of a static IP address).

When this feature is running, dynamic ARP learning on an interface will be disabled, since DHCP is the only authorized component currently allowed to add ARP entries.

The authorized ARP is enabled only in a DHCP server.

To limit the lease of IP addresses to authorized users, use the following command.

Command	Mode	Description
ip dhcp authorized-arp start <120-2147483637> **timeout** <120-2147483637>	Global	Discards an ARP response from unauthorized user. start: starting time (default: 3600 sec) timeout: expire time
ip dhcp authorized-arp <120-2147483637>		Discards an ARP response from unauthorized user. 120-2147483637: expire time
no ip dhcp authorized-arp		Disables the authorized ARP function.

You can verify the valid and invalid list for the authorized ARP. The valid list includes the IP addresses currently in lease, while the invalid list includes the IP addresses not in lease. Both lists include IP addresses of a DHCP pool, but the authorized ARP only allows the ARP response of the IP addresses in the valid list.

To display a list of valid and invalid IP addresses, use the following command.

Command	Mode	Description
show ip dhcp authorized-arp valid	Enable Global Bridge	Shows entries of the valid list.
show ip dhcp authorized-arp invalid		Shows entries of the invalid list.

To delete a list of invalid IP addresses, use the following command.

Command	Mode	Description
clear ip dhcp authorized-arp invalid	Enable Global Bridge	Deletes entries of the invalid IP addresses.

8.6.1.14 Prohibition of 1:N IP Address Assignment

The DHCP server may assign plural IP addresses to a single DHCP client in case of plural DHCP requests from the DHCP client which has the same hardware address. Some network devices may need plural IP addresses, but most DHCP clients like personal computers need only a single IP address. In this case, you can configure the switch to prohibit assigning plural IP addresses to a single DHCP client.

To prohibit assigning plural IP addresses to a DHCP client, use the following command.

Command	Mode	Description
ip dhcp check client-hardware-address	Global	Prohibits assigning plural IP addresses.
no ip dhcp check client-hardware-address		Permits assigning plural IP addresses.

8.6.1.15 Ignoring BOOTP Request

To allow a DHCP server to ignore received bootstrap protocol (BOOTP) request packets, use the following command.

Command	Mode	Description
ip dhcp bootp ignore	Global	Ignores BOOTP request packets.
no ip dhcp bootp ignore		Permits BOOTP request packets.

8.6.1.16 DHCP Packet Statistics

To display DHCP packet statistics of the DHCP server, use the following command.

Command	Mode	Description
show ip dhcp server statistics	Enable Global Bridge	Shows DHCP packet statistics.
clear ip dhcp statistics		Deletes collected DHCP packet statistics.

The following is an example of displaying DHCP packet statistics.

```
SWITCH(config)# show ip dhcp server statistics

 ========================================
 Message             Recieved/Error(0/0)
 ----------------------------------------
 DHCP DISCOVER               0
 DHCP REQUEST                0
 DHCP DECLINE                0
 DHCP RELEASE                0
 DHCP INFORM                 0

 ========================================
 Message             Sent/Error(0/0)
 ----------------------------------------
 DHCP OFFER                  0
 DHCP ACK                    0
 DHCP NAK                    0

SWITCH(config)#
```

8.6.1.17 Setting DHCP Pool Size

To limit a size of DHCP pool, use the following command.

Command	Mode	Description
ip dhcp max-pool-size <1-8>	Global	Configures a maximum size of DHCP pool.

8.6.1.18 Displaying DHCP Pool Configuration

To display a DHCP pool configuration, use the following command.

Command	Mode	Description
show ip dhcp pool [*POOL*]	Enable Global Bridge	Shows a DHCP pool configuration.
show ip dhcp pool summary [*POOL*]		Shows a summary of a DHCP pool configuration. POOL: pool name

The following is an example of displaying a DHCP pool configuration.

```
SWITCH(config)# show ip dhcp pool summary
[Total -- 1 Pools]
 Total      0                                0.00 of total
 Available  0                                0.00 of total
 Abandon    0                                0.00 of total
 Bound      0                                0.00 of total
 Offered    0                                0.00 of total
 Fixed      0                                0.00 of total

[sample]

 Total      0            0.00% of the pool    0.00 of total
 Available  0            0.00% of the pool    0.00 of total
 Abandon    0            0.00% of the pool    0.00 of total
 Bound      0            0.00% of the pool    0.00 of total
 Offered    0            0.00% of the pool    0.00 of total
 Fixed      0            0.00% of the pool    0.00 of total

SWITCH(config)#
```

8.6.2 DHCP Address Allocation with Option 82

The DHCP server provided by the switch can assign dynamic IP addresses based on DHCP option 82 information sent by the DHCP relay agent.

The information sent via DHCP option 82 will be used to identify which port the DHCP_REQUEST came in on. The feature introduces a new DHCP class capability, which is a method to group DHCP clients based on some shared characteristics other than the subnet in which the clients reside. The DHCP class can be configured with option 82 information and a range of IP addresses.

8.6.2.1 DHCP Class Capability

To enable the DHCP server to use a DHCP class to assign IP addresses, use the following command.

Command	Mode	Description
ip dhcp use class	Global	Enables the DHCP server to use a DHCP class to assign IP addresses.
no ip dhcp use class		Disables the DHCP server to use a DHCP class.

8.6.2.2 DHCP Class Creation

To create a DHCP class, use the following command.

Command	Mode	Description
ip dhcp class *CLASS*	Global	Creates a DHCP class and opens *DHCP Class Configuration* mode. CLASS: DHCP class name
no ip dhcp class [*CLASS*]		Deletes a created DHCP class.

8.6.2.3 Relay Agent Information Pattern

To specify option 82 information for IP assignment, use the following command.

Command	Mode	Description
relay-information remote-id ip *A.B.C.D* [**circuit-id** {**hex** *HEXSTRING* | **index** <0-65535> | **text** *STRING*}]	DHCP Class	Specifies option 82 information for IP assignment.
relay-information remote-id hex *HEXSTRING* [**circuit-id** {**hex** *HEXSTRING* | **index** <0-65535> | **text** *STRING*}]		
relay-information remote-id text *STRING* [**circuit-id** {**hex** *HEXSTRING* | **index** <0-65535> | **text** *STRING*}]		

To delete specified option 82 information for IP assignment, use the following command.

Command	Mode	Description
no relay-information remote-id ip *A.B.C.D* [**circuit-id** {**hex** *HEXSTRING* | **index** <0-65535> | **text** *STRING*}]	DHCP Class	Deletes specified option 82 information for IP assignment.
no relay-information remote-id hex *HEXSTRING* [**circuit-id** {**hex** *HEXSTRING* | **index** <0-65535> | **text** *STRING*}]		
no relay-information remote-id text *STRING* [**circuit-id** {**hex** *HEXSTRING* | **index** <0-65535> | **text** *STRING*}]		

To delete specified option 82 information for IP assignment, use the following command.

Command	Mode	Description
no relay-information remote-id all	DHCP Class	Deletes all specified option 82 information that contains only a remote ID.
no relay-information all		Deletes all specified option 82 information.

8.6.2.4 Associating DHCP Class

To associate a DHCP class with a current DHCP pool, use the following command.

Command	Mode	Description
class *CLASS*	DHCP Pool	Associates a DHCP class with a DHCP pool and opens *DHCP Pool Class Configuration* mode. CLASS: DHCP class name
no class [*CLASS*]		Releases an associated DHCP class from a current DHCP pool.

8.6.2.5 Range of IP Address for DHCP Class

To specify a range of IP addresses for a DHCP class, use the following command.

Command	Mode	Description
address range *A.B.C.D A.B.C.D*	DHCP Pool Class	Specifies a range of IP addresses. A.B.C.D: start/end IP address
no address range *A.B.C.D A.B.C.D*		Deletes a specified range of IP addresses.

A range of IP addresses specified with the **address range** command is valid only for a current DHCP pool. Even if you associate the DHCP class with another DHCP pool, the specified range of IP addresses will not be applicable.

8.6.3 DHCP Lease Database

8.6.3.1 DHCP Database Agent

The switch provides a feature that allows to a DHCP server automatically saves a DHCP lease database on a DHCP database agent.

The DHCP database agent should be a TFTP server, which stores a DHCP lease database as numerous files in the form of **leasedb.***MAC-ADDRESS*, e.g. **leasedb.***0A:31:4B:1A:77:6A*. The DHCP lease database contains a leased IP address, hardware address, etc.

To specify a DHCP database agent and enable an automatic DHCP lease database back-up, use the following command.

Command	Mode	Description
ip dhcp database *A.B.C.D INTERVAL*	Global	Specifies a DHCP database agent and back-up interval. A.B.C.D: DHCP database agent address INTERVAL: 120-2147483637 (unit: second)
no ip dhcp database		Deletes a specified DHCP database agent.

i Upon entering the **ip dhcp database** command, the back-up interval will begin.

To display a configuration of the DHCP database agent, use the following command.

Command	Mode	Description
show ip dhcp database	Enable Global Bridge	Shows a configuration of the DHCP database agent.

8.6.3.2 Displaying DHCP Lease Status

To display current DHCP lease status, use the following command.

Command	Mode	Description
show ip dhcp lease {**all** | **bound** | **abandon** | **offer** | **fixed** | **free**} [*POOL*]	Enable Global Bridge	Shows current DHCP lease status. all: all IP addresses bound: assigned IP address abandon: illegally assigned IP address offer: IP address being ready to be assigned fixed: manually assigned IP address free: remaining IP address POOL: pool name
show ip dhcp lease detail [*A.B.C.D*]		

8.6.3.3 Deleting DHCP Lease Database

To delete a DHCP lease database, use the following command.

Command	Mode	Description
clear ip dhcp leasedb *A.B.C.D/M*	Enable Global	Deletes a DHCP lease database a specified subnet.
clear ip dhcp leasedb pool *POOL*		Deletes a DHCP lease database of a specified DHCP pool.
clear ip dhcp leasedb all		Deletes the entire DHCP lease database.

8.6.4 DHCP Relay Agent

A DHCP relay agent is any host that forwards DHCP packets between clients and servers. The DHCP relay agents are used to forward DHCP requests and replies between clients and servers when they are not on the same physical subnet. The DHCP relay agent forwarding is distinct from the normal forwarding of an IP router, where IP datagrams are switched between networks somewhat transparently.

By contrast, DHCP relay agents receive DHCP messages and then generate a new DHCP message to send out on another interface. The DHCP relay agent sets the gateway address and, if configured, adds the DHCP option 82 information in the packet and forwards it to the DHCP server. The reply from the server is forwarded back to the client after removing the DHCP option 82 information.

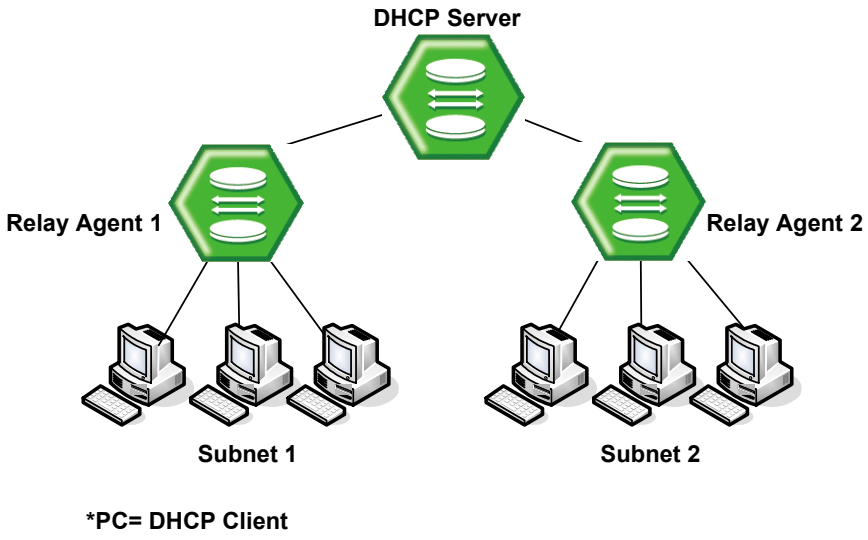


Fig. 8.35 Example of DHCP Relay Agent

To activate/deactivate the DHCP function in the system, use the following command.

Command	Mode	Description
service dhcp	Global	Activates the DHCP function in the system.
no service dhcp		Deactivates the DHCP function in the system.

Before configuring DHCP server or relay, you need to use the **service dhcp** command first to activate the DHCP function in the system.

8.6.4.1 DHCP Helper Address

A DHCP client sends DHCP_DISCOVER message to a DHCP server. DHCP_DISCOVER message is broadcasted within the network to which it is attached. If the client is on a network that does not have any DHCP server, the broadcast is not forwarded because the switch is configured to not forward broadcast traffic. To solve this problem, you can configure the interface that is receiving the broadcasts to forward certain classes of broadcast to a helper address.

To specify a DHCP helper address, use the following command.

Command	Mode	Description
ip dhcp helper-address *A.B.C.D*	Interface	Specifies a DHCP helper address. More than one address is possible. A.B.C.D: DHCP server address
no ip dhcp helper-address {*A.B.C.D* | **all**}		Deletes a specified packet forwarding address.

i If a packet forwarding address is specified on an interface, the switch will enable a DHCP relay agent.

You can also specify an organizationally unique identifier (OUI) when configuring a DHCP helper address. The OUI is a 24-bit number assigned to a company or organization for use in various network hardware products which is a first 24 bits of a MAC address. If an OUI is specified, a DHCP relay agent will forward DHCP_DISCOVER message to a specific DHCP server according to a specified OUI.

To specify a DHCP helper address with an OUI, use the following command.

Command	Mode	Description
ip dhcp oui *XX:XX:XX* **helper-address** *A.B.C.D*	Interface	Specifies a DHCP helper address with an OUI. More than one address is possible. XX:XX:XX: OUI (first 24 bits of a MAC address in the form of hexadecimal) A.B.C.D: DHCP server address
no ip dhcp oui *XX:XX:XX* [**helper-address** *A.B.C.D*]		Deletes a specified DHCP helper address.

8.6.4.2 Smart Relay Agent Forwarding

Normally, a DHCP relay agent forwards DHCP_DISCOVER message to a DHCP server only with a primary IP address on an interface, even if there is more than one IP address on the interface.

If the smart relay agent forwarding is enabled, a DHCP relay agent will retry sending DHCP_DISCOVER message with a secondary IP address, in case of no response from the DHCP server.

To enable the smart relay agent forwarding, use the following command.

Command	Mode	Description
ip dhcp smart-relay	Global	Enables a smart relay.
no ip dhcp smart-relay		Disables a smart relay.

8.6.4.3 DHCP Server ID Option

In case that more than two DHCP servers are connected to one DHCP relay agent, if the relay agent is supposed to broadcast the DHCP_DISCOVER message sent from a DHCP client to all connected DHCP servers, and then the servers will return DHCP_OFFER

message. The relay agent, however, will forward only one DHCP_OFFER message of the responses from the servers to the DHCP client. The DHCP client will try to respond to the server which sent the DHCP_OFFER with DHCP_REQUEST message, but the relay agent broadcasts it to all the DHCP servers again.

To prevent the unnecessary broadcast like this, you can configure a DHCP relay agent to aware the server ID. This will allow the DHCP relay agent to forward DHCP_REQUEST message to only one DHCP server with the unicast form under the multiple server environment.

To enable/disable a DHCP relay agent to recognize the DHCP server ID option in the forwarded DHCP_REQUEST message, use the following command.

Command	Mode	Description
ip dhcp relay aware-server-id	Global	Enables the system to recognize the DHCP server ID in the DHCP_REQUEST message.
no ip dhcp relay aware-server-id		Disables the DHCP server ID recognition option.

8.6.4.4 DHCP Relay Statistics

To display DHCP relay statistics, use the following command.

Command	Mode	Description
show ip dhcp relay statistics all	Enable Global Bridge	Shows DHCP relay statistics for all the interfaces.
show ip dhcp relay statistics vlan *VLANS*		Shows DHCP relay statistics for a specified VLAN.

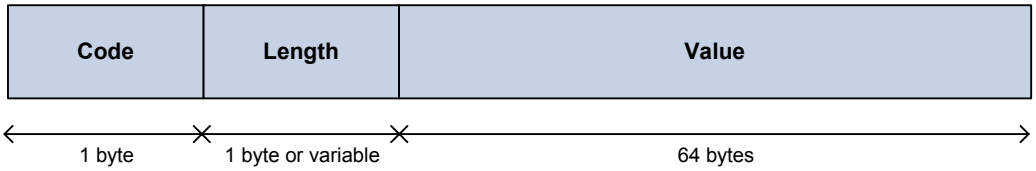
To delete collected DHCP relay statistics, use the following command.

Command	Mode	Description
clear ip dhcp relay statistics	Enable Global Bridge	Deletes collected DHCP relay statistics.

8.6.5 DHCP Option

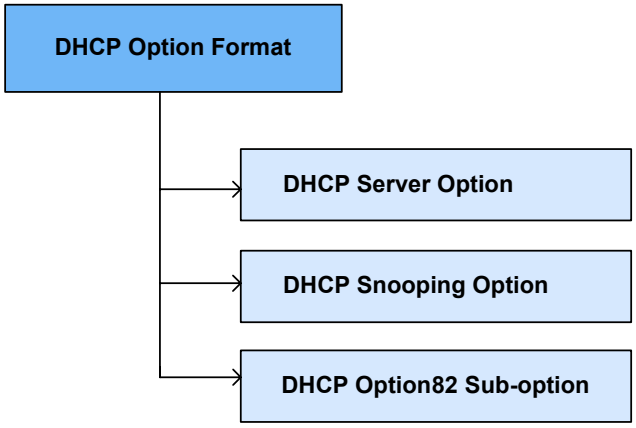
This function enables administrators to define DHCP options that are carried in the DHCP communication between DHCP server and client or relay agent. The following indicates the format of the DHCP options field.

DHCP Option Format



A code identifies each DHCP option. It can be expressed in value 0 to 255 by user configuration and some of them are predefined in the standards. (128 ~ 254 is site specific) A length can be variable according to value or can be fixed. A value contains actual information such an IP address, string, or index, which is inserted into the DHCP packet.

Administrators can configure a DHCP option format in *DHCP Option* mode, which is globally used over the DHCP functions. The DHCP option format can be applied in other DHCP software modules and the following figure indicates it.



8.6.5.1 Entering DHCP Option Mode

To enter the DHCP option mode, use the following command.

Command	Mode	Description
ip dhcp option format *NAME*	Global	Enters the DHCP option mode. NAME: DHCP option format name

8.6.5.2 Configuring DHCP Option Format

To configure a DHCP option format, use the following command.

Command	Mode	Description
attr <1-32> **type** <0-255> **length** {<1-64> | **variable**} **value** {**hex** | **index** | **ip** | **string**} *VALUE*	DHCP Option	Sets the type, length, and value of an attribute for a DHCP option. attr: They can be made in a DHCP option and are applied in order of attribute value (1-32). type: The type of a value length: The length of a value. It could be a fixed length by user input or a variable length according to the actual value length. value: The actual value of an option
attr <1-32> **type** <0-255> **length-hidden** {<1-64> | **variable**} **value** {**hex** | **index** | **ip** | **string**} *VALUE*		
attr <1-32> **length variable value** {**hex** | **index** | **ip** | **string**} *VALUE*		Sets the length and value of an attribute for a DHCP option.
attr <1-32> **length** <1-64> **value** {**hex** | **index** | **ip** | **string**} *VALUE*		
attr <1-32> **length-hidden variable value** {**hex** | **index** | **ip** | **string**} *VALUE*		Sets the value of an attribute for a DHCP option..
attr <1-32> **length-hidden** <1-64> **value** {**hex** | **index** | **ip** | **string**} *VALUE*		
no attr <1-32>	DHCP Option	Deletes the given attribute.

- The value should be within 64 bytes.
- A hidden-length variable should be set once in a single attribute.
- The total length of an option format cannot exceed 254 bytes.

8.6.5.3 Deleting DHCP Option Format

To delete a specified DHCP option format, use the following command.

Command	Mode	Description
no ip dhcp option format *NAME*	Global	Deletes the given DHCP option format.

8.6.5.4 Displaying DHCP option

To print a specified DHCP option format, use the following command.

Command	Mode	Description
show ip dhcp option format *NAME* [**port** *PORTS* **vlan** *VLANS*]	Enable Global DHCP Option	Prints the given option format and actual raw data in the packet.

8.6.6 DHCP Option 82

In some networks, it is necessary to use additional information to further determine which IP addresses to allocate. By using the DHCP option 82, a DHCP relay agent can include additional information about itself when forwarding client-originated DHCP packets to a DHCP server. The DHCP relay agent will automatically add the circuit ID and the remote ID to the option 82 field in the DHCP packets and forward them to the DHCP server.

The DHCP option 82 resolves the following issues in an environment in which untrusted hosts access the internet via a circuit based public network:

Broadcast Forwarding

The DHCP option 82 allows a DHCP relay agent to reduce unnecessary broadcast flooding by forwarding the normally broadcasted DHCP response only on the circuit indicated in the circuit ID.

DHCP Address Exhaustion

In general, a DHCP server may be extended to maintain a DHCP lease database with an IP address, hardware address and remote ID. The DHCP server should implement policies that restrict the number of IP addresses to be assigned to a single remote ID.

Static Assignment

A DHCP server may use the remote ID to select the IP address to be assigned. It may permit static assignment of IP addresses to particular remote IDs, and disallow an address request from an unauthorized remote ID.

IP Spoofing

A DHCP client may associate the IP address assigned by a DHCP server in a forwarded DHCP_ACK message with the circuit to which it was forwarded. The circuit access device may prevent forwarding of IP packets with source IP addresses, other than, those it has associated with the receiving circuit. This prevents simple IP spoofing attacks on the central LAN, and IP spoofing of other hosts.

MAC Address Spoofing

By associating a MAC address with a remote ID, a DHCP server can prevent offering an IP address to an attacker spoofing the same MAC address on a different remote ID.

Client Identifier Spoofing

By using the agent-supplied remote ID option, the untrusted and as-yet unstandardized client identifier field need not be used by the DHCP server.

Fig. 8.36 shows how the DHCP relay agent with the DHCP option 82 operates.

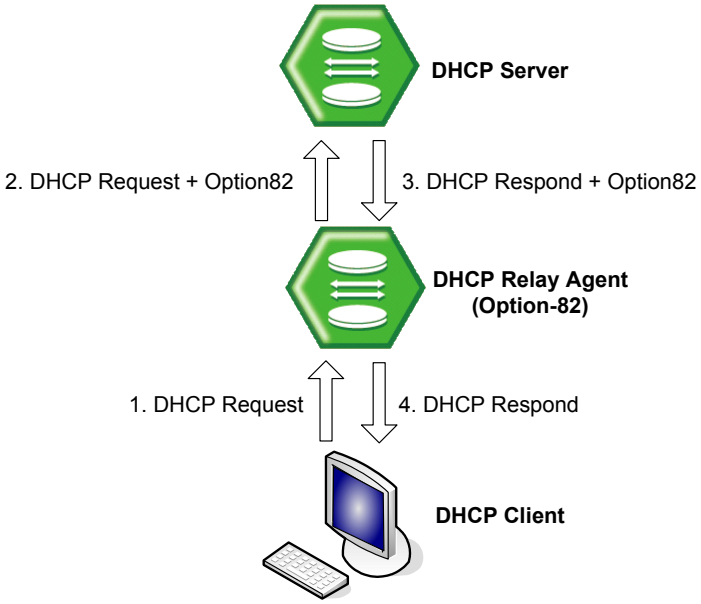


Fig. 8.36 DHCP Option 82 Operation

8.6.6.1 Enabling DHCP Option 82

To enable/disable the DHCP option 82, use the following command.

Command	Mode	Description
ip dhcp option82	Global	Enables the system to add the DHCP option 82 field.
no ip dhcp option82		Disables the system to add the DHCP option 82 field.

8.6.6.2 Option 82 Sub-Option

The DHCP option 82 enables a DHCP relay agent to include information about itself when forwarding client-originated DHCP packets to a DHCP server. The DHCP server can use this information to implement security and IP address assignment policies.

There are 2 sub-options for the DHCP option 82 information as follows:

- **Remote ID**
  This sub-option may be added by DHCP relay agents which terminate switched or permanent circuits and have mechanisms to identify the remote host of the circuit. Note that, the remote ID must be globally unique.
- **Circuit ID**
  This sub-option may be added by DHCP relay agents which terminate switched or permanent circuits. It encodes an agent-local identifier of the circuit from which a DHCP client-to-server packet was received. It is intended for use by DHCP relay agents in forwarding DHCP responses back to the proper circuit.

To specify a remote ID, use the following command.

Command	Mode	Description
system-remote-id hex *HEXSTRING*	Option 82	Specifies a remote ID. (default: system MAC address)
system-remote-id ip *A.B.C.D*		
system-remote-id text *STRING*		
system-remote-id option format *NAME*		

To specify a circuit ID, use the following command.

Command	Mode	Description
system-circuit-id *PORT* **hex** *HEXSTRING*	Option 82	Specifies a circuit ID. (default: port number)
system-circuit-id *PORT* **index** <0-65535>		
system-circuit-id *PORT* **text** *STRING*		
system-circuit-id port-type physical		
system-circuit-id *PORT* **option format** *NAME*		

To delete a specified remote and circuit ID, use the following command.

Command	Mode	Description
no system-remote-id	Option 82	Deletes a specified remote and circuit ID
no system-remote-id option format		
no system-circuit-id *PORT* [**option format**]		
no system-circuit-id port-type physical		

8.6.6.3 Option 82 Reforwarding Policy

A DHCP relay agent may receive a DHCP packet from a DHCP server or another DHCP relay agent that already contains relay information. You can specify a DHCP option 82 reforwarding policy to be suitable for the network.

To specify a DHCP option 82 reforwarding policy, use the following command.

Command	Mode	Description
policy {**replace** | **keep**}	Option 82	Specifies a DHCP option 82 reforwarding policy. replace: replaces an existing DHCP option 82 information with a new one. keep: keeps an existing DHCP option 82 information (default).
policy drop {**normal** | **option82** | **none**}		normal: DHCP packet option82: DHCP option 82 packet none: no DHCP packet (default)

8.6.6.4 Option 82 Trust Policy

Default Trust Policy

To specify the default trust policy for DHCP packets, use the following command.

Command	Mode	Description
trust default {**deny** | **permit**}	Option 82	Specifies the default trust policy for a DHCP packet.

i If you specify the default trust policy as **deny**, the DHCP packet that carries the information you specifies below will be permitted, and vice versa.

Trusted Remote ID

To specify a trusted remote ID, use the following command.

Command	Mode	Description
trust remote-id hex *HEXSTRING*	Option 82	Specifies a trusted remote ID.
trust remote-id ip *A.B.C.D*		
trust remote-id text *STRING*		

To delete a specified trusted remote ID, use the following command.

Command	Mode	Description
no trust remote-id hex *HEXSTRING*	Option 82	Deletes a specified trusted remote ID.
no trust remote-id ip *A.B.C.D*		
no trust remote-id text *STRING*		

Trusted Physical Port

To specify a trusted physical port, use the following command.

Command	Mode	Description
trust port *PORTS* {**normal** | **option82** | **all**}	Option 82	Specifies a trusted physical port. normal: DHCP packet option82: DHCP option 82 packet all: DHCP + option 82 packet
no trust port {**all** | PORTS} {**normal** | **option82** | **all**}		Deletes a specified trusted port.

8.6.7 DHCP Snooping

For enhanced security, the switch provides the DHCP snooping feature. The DHCP snooping filters untrusted DHCP messages and builds/maintains a DHCP snooping binding table. The untrusted DHCP message is a message received from outside the network, and an untrusted interface is an interface configured to receive DHCP messages from outside the network.

The DHCP snooping basically permits all the trusted messages received from within the network and filters untrusted messages. In case of untrusted messages, all the binding entries are recorded in a DHCP snooping binding table. This table contains a hardware address, IP address, lease time, VLAN ID, interface, etc.

It also gives you a way to differentiate between untrusted interfaces connected to the end-user and trusted interfaces connected to the DHCP server or another switch.

The DHCP snooping only filters the DHCP server message such as a DHCP_OFFER or DHCP_ACK which is received from untrusted interfaces.

8.6.7.1 Enabling DHCP Snooping

To enable the DHCP snooping globally, use the following command

Command	Mode	Description
ip dhcp snooping	Global	Enables the DHCP snooping globally.
no ip dhcp snooping		Disables the DHCP snooping globally. (default)

Upon enabling the DHCP snooping, the DHCP_OFFER and DHCP_ACK messages from all the ports will be discarded before specifying a trusted port.

To enable the DHCP snooping on a VLAN, use the following command

Command	Mode	Description
ip dhcp snooping vlan *VLANS*	Global	Enables the DHCP snooping on a specified VLAN.
no ip dhcp snooping vlan *VLANS*		Disables the DHCP snooping on a specified VLAN.

You must enable DHCP snooping globally before enabling DHCP snooping on a VLAN.

8.6.7.2 DHCP Trust State

To define a state of a port as trusted or untrusted, use the following command.

Command	Mode	Description
ip dhcp snooping trust *PORTS*	Global	Defines a state of a specified port as trusted.
no ip dhcp snooping trust *PORTS*		Defines a state of a specified port as untrusted. (default)

To discard broadcast request packets of Egress traffic on specified trusted port, use the following command.

Command	Mode	Description
ip dhcp snooping trust *PORTS* **filter egress bcast-req**	Global	Blocks broadcast request packets of Egress traffic on specified trusted port.
no ip dhcp snooping trust *PORTS* **filter egress bcast-req**		Unblocks broadcast request packets of Egress traffic on specified trusted port.

8.6.7.3 DHCP Rate Limit

To set the number of DHCP packets per second (pps) that an interface can receive, use the following command.

Command	Mode	Description
ip dhcp snooping limit-rate *PORTS* <1-255>	Global	Sets a rate limit for DHCP packets. (unit: pps)
no ip dhcp snooping limit-rate *PORTS*		Deletes a rate limit for DHCP packets.

Normally, the DHCP rate limit is specified to untrusted interfaces and 15 pps is recommended for a proper value. However, if you want to set a rate limit for trusted interfaces, keep in mind that trusted interfaces aggregate all DHCP traffic in the switch, and you will need to adjust the rate limit to a higher value.

8.6.7.4 DHCP Lease Limit

The number of entry registrations in DHCP snooping binding table can be limited. If there are too many DHCP clients on an interface and they request IP address at the same time, it may cause IP pool exhaustion.

To set the number of entry registrations in DHCP snooping binding table, use the following command.

Command	Mode	Description
ip dhcp snooping limit-lease *PORTS* <1-2147483637>	Global	Enables a DHCP lease limit on a specified untrusted port. 1-2147483637: the number of entry registrations
no ip dhcp snooping limit-lease *PORTS*		Deletes a DHCP lease limit.

You can limit the number of entry registrations only for untrusted interfaces, because the DHCP snooping binding table only contains the information for DHCP messages from untrusted interfaces.

8.6.7.5 Source MAC Address Verification

The switch can verify that the source MAC address in a DHCP packet that is received on untrusted ports matches the client hardware address in the packet.

To enable the source MAC address verification, use the following command.

Command	Mode	Description
ip dhcp snooping verify mac-address	Global	Enables the source MAC address verification.
no ip dhcp snooping verify mac-address		Disables the source MAC address verification.

8.6.7.6 Static DHCP Snooping Binding

The DHCP snooping binding table contains a hardware address, IP address, lease time, VLAN ID, and port information that correspond to the untrusted interfaces of the system.

To manually specify a DHCP snooping binding entry, use the following command.

Command	Mode	Description
ip dhcp snooping binding <1-4094> *PORT A.B.C.D MAC-ADDR* <120-2147483637>	Global	Configures binding on DHCP snooping table. 1-4094: VLAN ID PORT: port number A.B.C.D: IP address MAC-ADDR: MAC address 120-2147483637: lease time (unit: second)
ip dhcp snooping binding <1-4094> *PORT A.B.C.D MAC-ADDR* **infinite**		Configures infinite binding on DHCP snooping table.
clear ip dhcp snooping binding *PORT* {*A.B.C.D* | **all**}		Deletes a specified static DHCP snooping binding. all: all DHCP snooping bindings

8.6.7.7 DHCP Snooping Database Agent

When DHCP snooping is enabled, the system uses the DHCP snooping binding database to store information about untrusted interfaces. Each database entry (binding) has an IP address, associated MAC address, lease time, interface to which the binding applies and VLAN to which the interface belongs.

To maintain the binding when reload the system, you must use DHCP snooping database agent. If the agent is not used, the DHCP snooping binding will be lost when the switch is rebooted. The mechanism for the database agent saves the binding in a file at a remote location. Upon reloading, the switch reads the file to build the database for the binding. The system keeps the current file by writing to the file as the database changes.

To specify a DHCP database agent and enable an automatic DHCP snooping database back-up, use the following command.

Command	Mode	Description
ip dhcp snooping database *A.B.C.D INTERVAL*	Global	Specifies a DHCP snooping database agent and back-up interval. A.B.C.D: DHCP snooping database agent address INTERVAL: 120-2147483637 (unit: second)
no ip dhcp snooping database		Deletes a specified DHCP snooping database agent.

To request snooping binding entries from a DHCP snooping database agent, use the following command.

Command	Mode	Description
ip dhcp snooping database renew *A.B.C.D*	Global	Requests snooping binding entries from a DHCP snooping database agent. A.B.C.D: DHCP snooping database agent address

The DHCP snooping database agent should be TFTP server.

8.6.7.8 DHCP Snooping Filtering

If there are incoming packets to a port of switch enabled with DHCP snooping, it refers to DHCP snooping binding table and filters these packets whether their information is registered in the table or not. DHCP snooping filtering function supports three modes that are classified into filter, bypass and permit. Filter mode permits the registered packets only according to DHCP snooping binding table. Both permit and bypass mode permits all packets irrespective of DHCP snooping binding table. Both modes are written the filter entries, but they do not filter packets. Permit mode uses a filter-delay timer to be changed to filter mode. Otherwise, bypass mode uses a filter-delay counter.

DHCP snooping filter mode is not available in the system that is enabled with IP source guard function.

To select one of DHCP snooping filter modes, use the following command.

Command	Mode	Description
ip dhcp snooping filter-mode *PORTS* { **permit** | **bypass** | **filter** }	Global	Selects DHCP snooping filter mode and specifies an action by DHCP snooping binding table
no ip dhcp snooping filter-mode *PORTS*		Deletes the configured DHCP snooping filter mode.

When the system is running in one of Permit and Bypass modes, the authorized ARP function is not available.

To configure the automatic change from permit mode to filter mode right after the time exceeds configured time value, use the following command.

Command	Mode	Description
ip dhcp snooping filter-delay timer *PORTS* <1-2147483637>	Global	Configures an automatic change from bypass mode to filter mode after filter-delay time. 1-2147483637: filter-delay time value

To configure the automatic change from bypass mode to filter mode when the numer of filter enteries exceeds configured counter value, use the following command.

Command	Mode	Description
ip dhcp snooping filter-delay counter *PORTS* <1-2147483637>	Global	Configures an automatic change from bypass mode to filter mode when the filter enteries exceed the counter. 1-2147483637: filter-delay counter value

To delete configured filter-delay timer and counter, use the following command.

Command	Mode	Description
no ip dhcp snooping filter-delay *PORTS*	Global	Deltes a configured filter-delay timer and counter.

To display the status of DHCP snooping filtering, use the following command.

Command	Mode	Description
show ip dhcp snooping filter	Enable Global	Shows a DHCP snooping filter.
show ip dhcp snooping filter entry		Shows DHCP snooping binding entries.

8.6.7.9 Authorized ARP

This function sets the time before ARP inspection starts to run. Before setting this, ARP inspection should be enabled. ARP inspection checks validity of incoming ARP packets by using DHCP snooping binding table and denies the ARP packets if they are not identified in the table. However, this switch may be rebooted with any reason, then DHCP snooping bindinge enries, which are dynamically learned from ARP packets back and forth switch would be lost. Thus, ARP-inspection should be delayed to start during some time so that DHCP snooping table can build entries. If no time given, ARP inspection sees empty snooping table and drop every ARP packet.

To specify the ARP inspection delay time, use the following command.

Command	Mode	Description
ip dhcp snooping arp-inspection start <1-2147483637>	Global	Configures the ARP inspection delay time. If reboot, ARP-inspection resumes after the time you configure. 1-2147483637: delay time (unit: second)
no ip dhcp snooping arp-inspection start		Delete the configured ARP inspection delay time.

8.6.7.10 DHCP Snooping with Option82

In case of L2 environment, when forwarding DHCP messages to a DHCP server, a DHCP switch can insert or remove DHCP option82 data on the DHCP messages from the clients.

In case of a switch is enabled with DHCP snooping, it floods DHCP packets with DHCP option82 field when the DHCP option82 is enabled. This allows an enhanced security and efficient IP assignment in the Layer 2 environment with a DHCP option82 field.

i If DHCP snooping is enabled in the system of switch, DHCP packets includes DHCP option82 field by default.

To enable/disable the switch enabled by DHCP snooping to insert or remove DHCP option82 field, use the following command.

Command	Mode	Description
ip dhcp snooping information option	Global	Enables the switch to insert DHCP option 82 field in forwarded DHCP packets to the DHCP server.
no ip dhcp snooping information option		Disables the switch not to insert DHCP option 82 field in forwarded DHCP packets to the DHCP server

8.6.7.11 DHCP Snooping Option

DHCP snooping switch may receive DHCP messages (Discover/Request) with various different options from clients, which cause DHCP server hard to manage client's information in the perspective of data consistency. That's why this function is necessay.

The switch operating DHCP snooping can modify or attach an option field of the DHCP messages (Discover/Request) with a defined snooping option and can forward them to DHCP server. The snooping option can be applied on a port basis or on entire ports. Before using this function, a global DHCP option format should be created. For details of setting the DHCP option format, refer to the 8.6.5 DHCP Option.

To set a DHCP snooping option for a specifc port, use the following command.

Command	Mode	Description
ip dhcp snooping port *PORTS* **opt-code** <1-254> **format** *NAME*	Global	Specifies a snooping option format on a port. opt-code: DHCP option code NAME: DHCP option format name
ip dhcp snooping port *PORTS* **opt-code** <1-254> **policy** {**keep** | **replace**}		Configures a policy against DHCP option belonging to a DHCP message (default: replace) keep: forwards a DHCP message to DHCP server without any modification. replace: deletes the DHCP message's option and adds the snooping option if both of them are same. However, if they are different each other, **replace** option just adds the snooping option.
no ip dhcp snooping port PORTS opt-code <1-254>		Removes the DHCP snooping option for a given port.

In case there is not a DHCP snooping option for a specific port, DHCP snooping switch finds the snooping default option. If it exists, DHCP snooping switch sends a DHCP server DHCP messages (Discover/Request) by replacing their options with the snooping default option.

To specify a DHCP server default option, use the following command.

Command	Mode	Description
ip dhcp snooping default-option code <1-254> **format** *NAME*	Global	Specifies a snooping default option format for a switch. NAME: DHCP option format name
ip dhcp snooping default-option code <1-254> **policy** <**keep** | **replace**>		Configures a policy against DHCP option belonging to a DHCP message (default: replace) keep: forwards a DHCP message to DHCP server without any modification. replace: deletes the DHCP message's option and adds the snooping default option if both of them are same. However, if they are different each other, **replace** option just adds the snooping default option.
no ip dhcp snooping default-option code <1-254>		Removes the DHCP snooping default option for a given port.

8.6.7.12 DHCP User Class ID

The switch can send the packets based on the policy or value of DHCP user class ID in the DHCP message sent by the client. The user class ID on DHCP option 77 field identifies the type of client sending the DHCP Discover/Request message.

If switch receives DHCP message from a client, it forwards the same packet to the server with **keep** policy of DHCP option 77. Otherwise, it adds user class ID to the packet on the configured port and forwards it to the server when the packet has no user class ID and the policy of DHCP option 77 is **replace**. DHCP server can use DHCP option 77 field to specify IP addresses of a particular pool based on user class ID of DHCP client.

To use DHCP option 77 fucntion, DHCP snooping must be enabled in the system of switch. In case DHCP snooping is disabled in the system, the configured DHCP option 77 is automatically deleted.

To configure a user class id of DHCP option 77 on a specified port, use the following command.

Command	Mode	Description
ip dhcp snooping user-class-id port *PORT* **class-id** *CLASS-ID*	Global	Configures DHCP user class ID of DHCP option 77 per port.

To configure the policy of DHCP option 77 on a specified port, use the following command.

Command	Mode	Description
ip dhcp snooping user-class-id port {**replace** | **keep**}	Global	Configures the policy of DHCP option 77 field for the DHCP Request packet (default: replace) replace: forwards DHCP packets with user class ID according to DHCP option 77 field format. keep: forwards DHCP packets without any user class ID

To delete the configured user class ID of DHCP option 77 field, use the following command.

Command	Mode	Description
no ip dhcp snooping user-class-id port *PORT* **class-id** *CLASS-ID*	Global	Deletes a configured user class ID of a port.
no ip dhcp snooping user-class-id port *PORT* **all**		Deletes all configured user class IDs of a port.

8.6.7.13 Displaying DHCP Snooping Configuration

To display DHCP snooping table, use the following command.

Command	Mode	Description
show ip dhcp snooping	Enable Global	Shows DHCP snooping configuration.
show ip dhcp snooping binding		Shows DHCP snooping binding entries.

8.6.8 IP Source Guard

IP source guard is similar to DHCP snooping. This function is used on DHCP snooping untrusted Layer 2 port. Basically, except for DHCP packets that are allowed by DHCP snooping process, all IP traffic comes into a port is blocked. If an authorized IP address from the DHCP server is assigned to a DHCP client, or if a static IP source binding is configured, the IP source guard restricts the IP traffic of client to those source IP addresses configured in the binding; any IP traffic with a source IP address other than that in the IP source binding will be filtered out. This filtering limits a host's ability to attack the network by claiming a neighbor host's IP address.

IP source guard supports the Layer 2 port only, including both access and trunk. For each untrusted Layer 2 port, there are two levels of IP traffic security filtering:

- **Source IP Address Filter**
  IP traffic is filtered based on its source IP address. Only IP traffic with a source IP address that matches the IP source binding entry is permitted. An IP source address filter is changed when a new IP source entry binding is created or deleted on the port, which will be recalculated and reapplied in the hardware to reflect the IP source binding change. By default, if the IP filter is enabled without any IP source binding on the port, a default policy that denies all IP traffic is applied to the port. Similarly, when the IP filter is disabled, any IP source filter policy will be removed from the interface.

- **Source IP and MAC Address Filter**
  IP traffic is filtered based on its source IP address as well as its MAC address; only IP traffic with source IP and MAC addresses matching the IP source binding entry are permitted. When IP source guard is enabled in IP and MAC filtering mode, the DHCP snooping option 82 must be enabled to ensure that the DHCP protocol works properly. Without option 82 data, the switch cannot locate the client host port to forward the DHCP server reply. Instead, the DHCP server reply is dropped, and the client cannot obtain an IP address.

8.6.8.1 Enabling IP Source Guard

After configuring DHCP snooping, configure the IP source guard using the provided command. When IP source guard is enabled with this option, IP traffic is filtered based on the source IP address. The switch forwards IP traffic when the source IP address matches an entry in the DHCP snooping binding database or a binding in the IP source binding table.

To enable IP source guard, DHCP snooping needs to be enabled.

To enable IP source guard with a source IP address filtering on a port, use the following command.

Command	Mode	Description
ip dhcp verify source *PORTS*	Global	Enables IP source guard with a source IP address filtering on a port.
no ip dhcp verify source *PORTS*		Disables IP source guard.

To enable IP source guard with a source IP address and MAC address filtering on a port, use the following command.

Command	Mode	Description
ip dhcp verify source port-security *PORTS*	Global	Enables IP source guard with a source IP address and MAC address filtering on a port.
no ip dhcp verify source port-security *PORTS*		Disables IP source guard.

Note that the IP source guard is only enabled on DHCP snooping untrusted Layer 2 port! If you try to enable this function on a trusted port, the error message will be shown up.

You cannot configure IP source guard with the **ip dhcp verify source** and **ip dhcp verify source port-security** commands together.

8.6.8.2 Static IP Source Binding

The IP source binding table has bindings that are learned by DHCP snooping or manually specified with the **ip dhcp verify source binding** command. The switch uses the IP source binding table only when IP source guard is enabled.

To specify a static IP source binding entry, use the following command.

Command	Mode	Description
ip dhcp verify source binding <1-4094> *PORT A.B.C.D MAC-ADDR*	Global	Specifies a static IP source binding entry. 1-4094: VLAN ID A.B.C.D: IP address MAC-ADDR: MAC address
no ip dhcp verify source binding {*A.B.C.D* | **all**}		Deletes a specified static IP source binding.

8.6.8.3 Displaying IP Source Guard Configuration

To display IP source binding table, use the following command.

Command	Mode	Description
show ip dhcp verify source binding	Enable Global	Shows IP source binding entries.

8.6.9 DHCP Client

An interface of the switch can be configured as a DHCP client, which can obtain an IP address from a DHCP server. The configurable DHCP client functionality allows a DHCP client to use a user-specified client ID, class ID or suggested lease time when requesting an IP address from a DHCP server. Once configured as a DHCP client, the switch cannot be configured as a DHCP server or relay agent.

8.6.9.1 Enabling DHCP Client

To configure an interface as a DHCP client, use the following command.

Command	Mode	Description
ip address dhcp	Interface	Enables a DHCP client on an interface.
no ip address dhcp		Disables a DHCP client.

8.6.9.2 DHCP Client ID

To specify a client ID, use the following command.

Command	Mode	Description
ip dhcp client client-id hex *HEXSTRING*	Interface	Specifies a client ID.
ip dhcp client client-id text *STRING*		
no ip dhcp client client-id		Deletes a specified client ID.

8.6.9.3 DHCP Class ID

To specify a class ID, use the following command.

Command	Mode	Description
ip dhcp client class-id hex *HEXSTRING*	Interface	Specifies a class ID. (default: system MAC address)
ip dhcp client class-id text *STRING*		
no ip dhcp client class-id		Deletes a specified class ID.

8.6.9.4 Host Name

To specify a host name, use the following command.

Command	Mode	Description
ip dhcp client host-name *NAME*	Interface	Specifies a host name.
no ip dhcp client host-name		Deletes a specified host name.

8.6.9.5 IP Lease Time

To specify IP lease time that is requested to a DHCP server, use the following command.

Command	Mode	Description
ip dhcp client lease-time <120-2147483637>	Interface	Specifies IP lease time in the unit of second (default: 3600).
no ip dhcp client lease-time		Deletes a specified IP lease time.

8.6.9.6 Requesting Option

To configure a DHCP client to request an option from a DHCP server, use the following command.

Command	Mode	Description
ip dhcp client request {**domain-name** | **dns**}	Interface	Configures a DHCP client to request a specified option.

To configure a DHCP client not to request an option, use the following command.

Command	Mode	Description
no ip dhcp client request {**domain-name** | **dns**}	Interface	Configures a DHCP client not to request a specified option.

8.6.9.7 Forcing Release or Renewal of DHCP Lease

The switch supports two independent operation: immediate release a DHCP lease for a DHCP client and force DHCP renewal of a lease for a DHCP client.

To force a release or renewal of a DHCP release for a DHCP client, use the following command.

Command	Mode	Description
release dhcp *INTERFACE*	Enable	Forces a release of a DHCP lease.
renew dhcp *INTERFACE*		Forces a renewal of a DHCP lease.

8.6.9.8 Displaying DHCP Client Configuration

To display a DHCP client configuration, use the following command.

Command	Mode	Description
show ip dhcp client *INTERFACE*	Enable Global Interface	Shows a configuration of DHCP client.

8.6.10 DHCP Filtering

8.6.10.1 DHCP Packet Filtering

For the switch, it is possible to block the specific client with MAC address. If the MAC address blocked by administrator requests an IP address, the server does not assign IP address. This function can provide the security of DHCP server.

Not to assign IP address for specific client of a port, use the following command.

Command	Mode	Description
ip dhcp filter-port *PORTS*	Global	Configures a port in order not to assign IP address.
no ip dhcp filter-port *PORTS*		Disables DHCP packet filtering.

Not to assign IP address for specific client with a specific MAC address, use the following command.

Command	Mode	Description
ip dhcp filter-address *MAC-ADDR*	Global	Blocks a MAC address in case of requesting IP address. MAC-ADDR: client's MAC address
no ip dhcp filter-address *MAC-ADDR*		Disables DHCP MAC filtering.

8.6.10.2 DHCP Server Packet Filtering

Dynamic Host Configuration Protocol (DHCP) makes DHCP server assign IP address to DHCP clients automatically and manage the IP address. Most ISP operators provide the service as such a way. At this time, if a DHCP client connects with the equipment that can be the other DHCP server such as Internet access gateway router, communication failure might be occurred.

DHCP filtering helps to operate DHCP service by blocking DHCP request which enters through subscriber's port and goes out into uplink port or the other subscriber's port and DHCP reply which enters to the subscriber's port.

In the Fig. 8.37, server A has the IP area from 192.168.10.1 to 192.168.10.10. Suppose a user connects with client 3 that can be DHCP server to A in order to share IP address from 10.1.1.1 to 10.1.1.10.

Here, if client 1 and client 2 are not blocked from client 3 of DHCP server, client 1 and client 2 will request and receive IP from client 3 so that communication blockage will be occurred. Therefore, the filtering function should be configured between client 1 and client 3, client 2 and client 3 in order to make client 1 and client 2 receive IP without difficulty from DHCP server A.

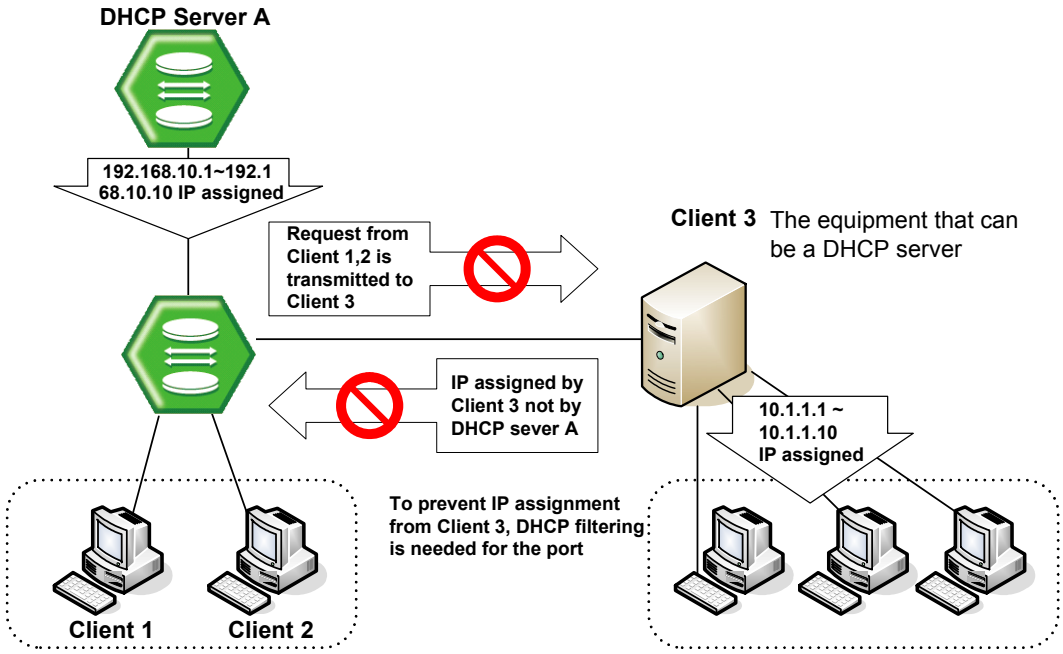


Fig. 8.37 DHCP Server Packet Filtering

To enable the DHCP server packet filtering, use the following command.

Command	Mode	Description
dhcp-server-filter *PORTS*	Bridge	Enables the DHCP server packet filtering.
no dhcp-server-filter *PORTS*		Disables the DHCP server packet filtering.

To display a status of the DHCP server packet filtering, use the following command.

Command	Mode	Description
show dhcp-server-filter	Enable Global Bridge	Show a status of the DHCP server packet filtering.

8.6.11 Debugging DHCP

To enable/disable a DHCP debugging, use the following command.

Command	Mode	Description
debug dhcp {filter | lease | packet | service | all}	Enable	Enables a DHCP debugging.
no debug dhcp {filter | lease | packet | service | all}		Disables a DHCP debugging.

8.7 Single IP Management

It is possible to manage several switches with one IP address by using stacking. If there is a limitation for using IP addresses and there are too many switches, which you must manage, you can manage a number of switches with one IP address using this stacking function.

It is named One IP Management because you can easily manage various switches and subscribers connected to the switch with this stacking function. The switch provides the function.

The following is an example of the network where stacking is configured.

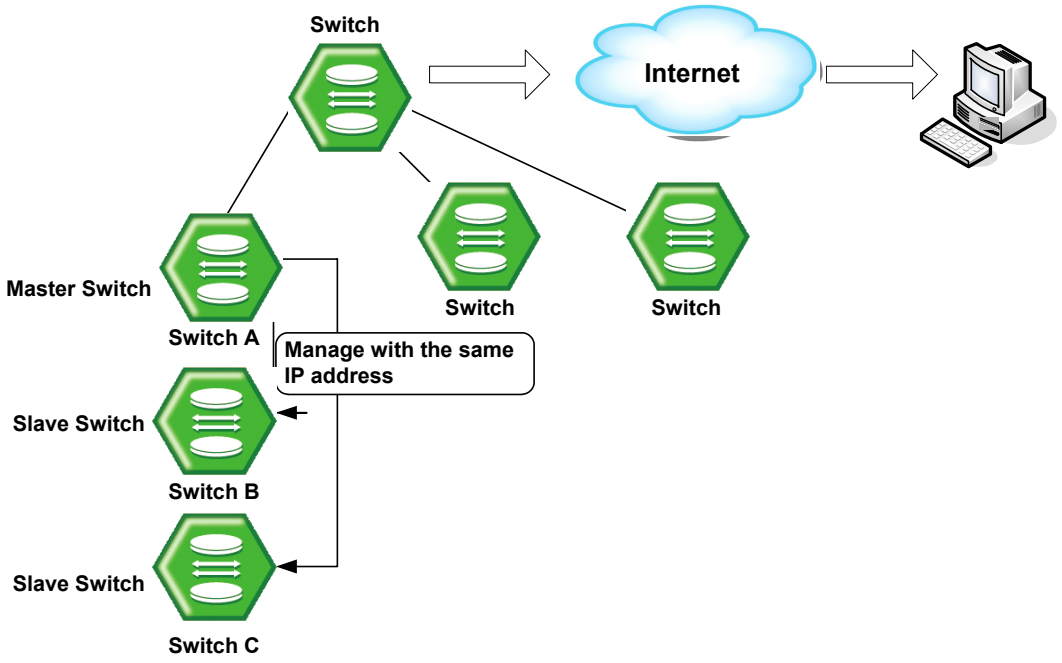


Fig. 8.38 Example of Single IP management

A switch, which is supposed to manage the other switches in stacking is named as Master switch and the other switches managed by Master switch are named as Slave switch. Regardless of installed place or connection state, Master switch can check and manage all Slave switches.

i It is possible to configure stacking function for switches from 2 to 16.

8.7.1 Switch Group

You should configure all the switches configured with stacking function to be in the same VLAN. To configure the switches as a switch group which belongs in the same VLAN, use the following command.

Command	Mode	Description
stack device *NAME*	Global	Configures device name or VID.

i For managing the stacking function, the port connecting Master switch and Slave switch must be in the same VLAN.

8.7.2 Designating Master and Slave Switch

Designate Master switch using the following command.

Command	Mode	Description
stack master	Global	Sets the switch as a master switch.

After designating Master switch, register Slave switch for Master switch. To register Slave switch or delete the registered Slave switch, use the following command.

Command	Mode	Description
stack add *MACADDR* [*DESCRIPTION*]	Global	Registers slave switch. MACADDR: MAC address
stack del *MAC-ADDR*		Deletes slave switch.

i To make stacking operate well, it is required to enable the interface of Slave switch. The switches in different VLANs cannot be added to the same switch group.

You should designate Slave switch registered in Master Switch as Slave Switch. To designate Slave switch, use the following command.

Command	Mode	Description
stack slave	Global	Sets the switch as a slave switch.

8.7.3 Disabling Stacking

To disable stacking, use the following command.

Command	Mode	Description
no stack	Global	Disables stacking.

8.7.4 Displaying Stacking Status

To display the status of stacking, use the following command.

Command	Mode	Description
show stack	Enable Global Bridge	Shows a configuration of stacking.

8.7.5 Accessing to Slave Switch from Master Switch

After configuring all stacking configurations, it is possible to configure and mange by accessing to Slave switch from Master switch.

To access to Slave switch from Master switch, use the following command in *Bridge Configuration* mode.

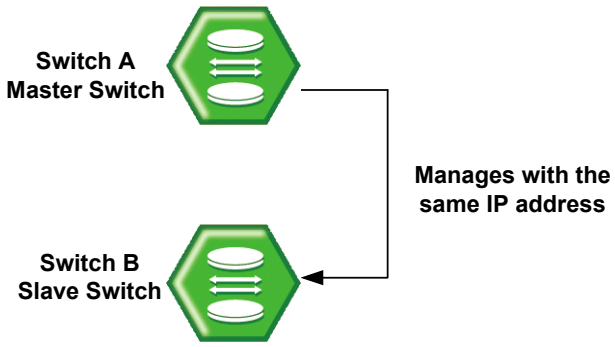
Command	Mode	Description
rcommand *NODE*	Enable	Accesses to a slave switch. NODE: node number

NODE means node ID from configuring stacking in Slave switch. If you input the above command in Master switch, Telnet connected to Slave switch is displayed and it is possible to configure Slave switch using DSH command. If you use the exit command in Telnet, the connection to Slave switch is down.

8.7.6 Sample Configuration

Sample Configuration 1: Configuring Stacking

The following is a stacking configuration by designating SWITCH A as a master and SWITCH B as a slave.



Step 1
Assign IP address in Interface configuration mode of Switch and enable interface using “no shutdown” command. In order to enter into Interface configuration mode, you should enter into Interface configuration mode of VLAN to register as a switch group for stacking.

The following is an example of configuring Interface of switch group as 1.

```
SWITCH_A# configure terminal
SWITCH_A(config)# interface 1
SWITCH_A(interface)# ip address 192.168.10.1/16
SWITCH_A(interface)# no shutdown
SWITCH_A(interface)#
```

i If there are several switches, rest of them are managed by IP address of Master switch. Therefore you don’t need to configure IP address in Slave switch.

Step 2
Configure Switch A as Master switch. Configure VLAN to belong in the same switch group and after registering Slave switch, configure it as a Master switch.

<Switch A – Master Switch>

```
SWITCH_A(config)# stack master
SWITCH_A(config)# stack device default
SWITCH_A(config)# stack add 00:d0:cb:22:00:11
```

Step 3
Configure VLAN in order to belong to the same switch group in Switch B registered in Master switch as Slave switch and configure as a Slave switch.

<Switch B – Slave Switch>

```
SWITCH_B(config)# stack slave
SWITCH_B(config)# stack device default
```

Step 4
Check the configuration. The information you can check in Master switch and Slave switch is different as below.

<Switch A – Master Switch>

```
SWITCH_A(config)# show stack
device  : default
node ID : 1
node   MAC address          status   type                 name      port
   1   00:d0:cb:0a:00:aa    active                        SWITCH    26
   2   00:d0:cb:22:00:11    active                        SWITCH    26
SWITCH_A(config)#
```

<Switch B – Slave Switch>

```
SWITCH_B(config)# show stack
device  : default
node ID : 2
SWITCH_B(config)#
```

Sample Configuration 2: Accessing from Master Switch to Slave Switch

The following is an example of accessing to Slave switch from Master switch configured in Sample Configuration 1. If you show the configuration of Slave switch in Sample Configuration 1, you can recognize node-number is 2.

```
SWITCH(bridge)# rcommand 2
Trying 127.1.0.1(23)...
Connected to 127.1.0.1.
Escape character is '^]'.
SWITCH login: admin
Password:
SWITCH#
```

To disconnect, input as the below.

```
SWITCH# exit
Connection closed by foreign host.
SWITCH(bridge)#
```

8.8 Rate Limit

User can customize port bandwidth according to user's environment. By this configuration, you can prevent a certain port to monopolize whole bandwidth so that all ports can use bandwidth equally. Egress and ingress can be configured both to be same and to be different.

The switch can apply the rate limit with 64 Kbps unit for GE port, and support ingress policing and egress shaping.

To set a port bandwidth, use the following command.

Command	Mode	Description
rate *PORTS RATE* [**egress** | **ingress**]	Bridge	Sets port bandwidth. If you input egress or ingress, you can configure outgoing packet or incoming packet. The unit is 64 Kbps. RATE:64-1,000,000
no rate *PORTS* [**egress** | **ingress**]		Clears rate configuration of a specific port by transmitting direction.

For the ingress rate limit, the flow control should be enabled on a specified port! For more information of the flow control, see Section 5.2.5.

To display a configured rate limit, use the following command.

Command	Mode	Description
show rate	Enable Global Bridge	Shows a configured rate limit.

8.9 Flood Guard

Flood-guard limits number of packets, how many packets can be transmitted, in configured bandwidth, whereas Rate limit controls packets through configuring width of bandwidth, which packets pass through. This function prevents receiving packets more than configured amount without enlarging bandwidth.

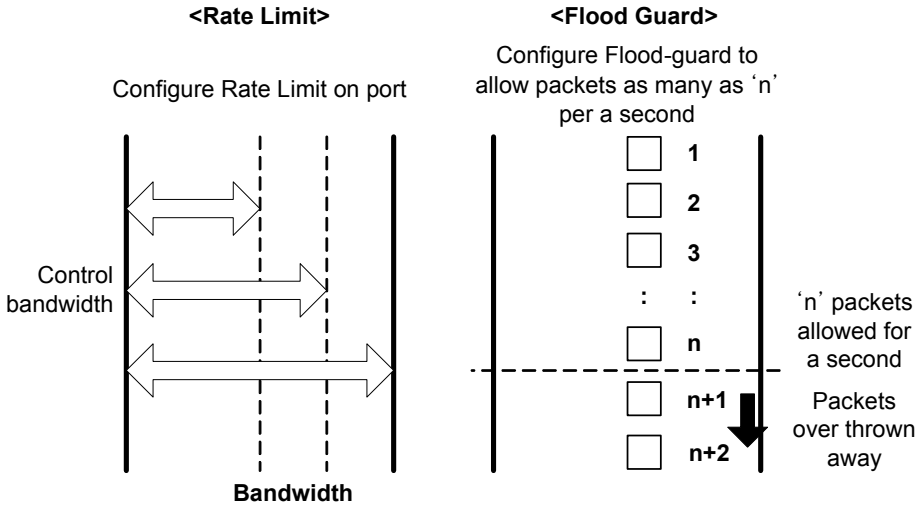


Fig. 8.39 Rate Limit and Flood Guard

8.9.1 MAC Flood-Guard

To configure the number of packets which can be transmitted in a second, use the following command.

Command	Mode	Description
mac-flood-guard *PORTS* <1-6000>	Bridge	Limits the number of packets which can be transmitted to the port for 1 second.
no mac-flood-guard [*PORTS*]		Disables a configured flood guard.

To display a configuration of flood guard, use the following command.

Command	Mode	Description
show mac-flood-guard	Enable Global Bridge	Shows a configured flood guard.
show mac-flood-guard macs		Shows a blocked MAC address.

8.9.2 CPU Flood-Guard

To specify the number of broadcast packets which are transmitted in CPU, use the following command.

Command	Mode	Description
cpu-flood-guard *PORTS* <1-6000>	Bridge	Limits the number of broadcast packets which are transmitted to CPU for 1 second.
no cpu-flood-guard [*PORTS*]		Disables a configured cpu flood guard.

To set the timer of limiting packet numbers that are incoming to CPU, use the following command.

Command	Mode	Description
cpu-flood-guard *PORTS* **timer** <10-3600>	Bridge	Sets the time for protecting from incoming broadcast packets. 10-3600: time value (default: 60 seconds)

To allow a specified port to be received the broadcast packet flooding manually, use the following command.

Command	Mode	Description
cpu-flood-guard *PORTS* **unblock**	Bridge	Limits the number of packets which can be transmitted to the port for 1 second.

To enable or disable CPU flood-guard function, use the following command.

Command	Mode	Description
cpu-flood-guard enable	Bridge	Enables CPU flood guard function.
no cpu-flood-guard disable		Disables CPU flood guard function.

To display a configuration of CPU flood-guard, use the following command.

Command	Mode	Description
show cpu-flood-guard	Enable Global Bridge	Shows a configured CPU flood guard.

8.9.3 Port Flood-Guard

A packet storm occurs unexpectedly when a large number of broadcast, unicast, or multicast packets are received on a port. Forwarding these packets can cause the network to slow down or to time out. This switch provides pps-control function that controls traffic for a specified port by threshold value. If a large number of incoming packets exceed the threshold, the traffic is discarded during specified time when pps-control function enables on this port.

To set the threshold of pps-control, use the following command.

Command	Mode	Description
pps-control port *PORTS THRESHOLD* {**5** | **60** | **600**}	Global	Sets the threshold of port traffic. PORTS: port number (1, 2, 3, …) THRESHOLD: threshold value (the number of packets per 1 second) 5 | 60 | 600: time interval (unit: second)
no pps-control port *PORTS*		Deletes the configured threshold of port traffic.

To set the timer for blocking traffic, use the following command.

Command	Mode	Description
pps-control port *PORTS* **block timer** <10-3600>	Global	Sets the time of changing the state of a blocked port to NORMAL. If you set the interval as 10, the state of the blocked port will be changed back to normal after 10 seconds. PORTS: port number (1, 2, 3, …) 10-3600: time (unit: second)
no pps-control port *PORTS* **block**		Disables the blocking timer option.

To show the configuration of pps-control function, use the following command.

Command	Mode	Description
show pps-control port [*PORTS*]	Enable Global Bridge	Shows the configured of pps control.

8.10 Storm Control

The switch provides a storm control feature for mass broadcast, multicast, and destination lookup failure (DLF). Generally, wrong network configuration, hardware malfunction, virus and so on cause these kinds of mass packets. Packet storm occupies most of the bandwidth of the network, and that causes the network very unstable.

To enable/disable the storm control, use the following command.

Command	Mode	Description
storm-control {**broadcast** | **dlf** | **multicast** } *RATE* [*PORTS*]	Bridge	Enables broadcast or DLF storm control respectively in a port with a user defined rate. RATE: 512-1024000kbps, step: 512kbps (GE)
no storm-control {**broadcast** [*PORTS*] **| multicast | dlf**}		Disables broadcast, multicast or DLF storm control respectively.

To display a configuration of the storm control, use the following command.

Command	Mode	Description
show storm-control	Enable/Global/Bridge	Displays a configuration of the storm control.

8.11 Jumbo Frame Capacity

The packet range that can be capable to accept is from 64 bytes to 1518 bytes. Therefore, packets not between these ranges will not be taken. However, the switch can accept jumbo frame larger than 1518 bytes through user's configuration.

To enable the jumbo frame capacity, use the following command.

Command	Mode	Description
jumbo-frame enable	Bridge	Configures to accept jumbo frame up to 9188 bytes.

To disable the jumbo frame capacity, use the following command.

Command	Mode	Description
jumbo-frame disable	Bridge	Disables configuration to accept jumbo frame.(default)

To display the configuration of jumbo frame, use the following command.

Command	Mode	Description
show jumbo-frame	Enable Global Bridge	Shows a configuration of jumbo frame.

The following is an example of enabling the jumbo frame capacity.

```
SWITCH(bridge)#jumbo-frame enable
SWITCH(bridge)# show jumbo-frame

        Name : Current/Default
        port01 :    9188/   1518
        port02 :    9188/   1518
        port03 :    9188/   1518
        port04 :    9188/   1518
        port05 :    9188/   1518
        port06 :    9188/   1518
        port07 :    9188/   1518
        port08 :    9188/   1518
        port09 :    9188/   1518
        port10 :    9188/   1518
--more--
SWITCH(bridge)#
```

8.12 Bandwidth

Routing protocol uses bandwidth information to measure routing distance value. To configure bandwidth of interface, use the following command.

Command	Mode	Description
bandwidth *BANDWIDTH*	Interface	Configures bandwidth of interface, enter the value of bandwidth.

i The bandwidth can be from 1 to 10,000,000 Kbits. This bandwidth is only valid for routing information implement and it does not concern any physical bandwidth.

To delete a configured bandwidth, use the following command.

Command	Mode	Description
no bandwidth *BANDWIDTH*	Interface	Deletes configured bandwidth of interface, enter the value.

8.13 Maximum Transmission Unit (MTU)

Maximum value for the length of the data payload can be transmitted. You can set a maximum transmission unit (MTU) with below command.

Command	Mode	Description
mtu <68-1500>	Interface	Sets a MTU size.
no mtu		Returns to the default MTU size.

9 IP Multicast

IP communication provides three types of packet transmission: unicast, broadcast and multicast. Unicast is the communication for a single source host to a single destination host. This is still the most common transmission form in the IP network. Broadcast is the communication for a single source host to all destination hosts on a network segment. This transmission is also widely used especially by network protocols, but it sometimes may not be efficient for those hosts in the subnet who are not participating in the broadcast. Multicast is the communication for a single or many source hosts to a specific group of destination hosts, which is interested in the information from the sources. This type of packet transmission can be deployed for a number of applications with more efficient utilization of the network infrastructure.

The point of implementing multicast is how to deliver source traffic to specific destinations without any burden on the sources or receivers using the minimized network bandwidth. The solution is to create a group of hosts with addressing the group, and to let the network determine how to replicate the source traffic to the receivers. The traffic will then be addressed to the multicast address and replicated to the multiple receivers by network devices. Standard multicast protocols such as IGMP provide most of these capabilities.

IP multicast features on the switch consist of the group membership management, Layer 2 multicast forwarding, which allows network administrators to successfully achieve the effective and flexible multicast deployment.

Fig. 9.1 shows an example of the IP multicast network. In this case, the switch is configured only with IGMP snooping (L2 multicast forwarding feature) in the Layer 2 network.

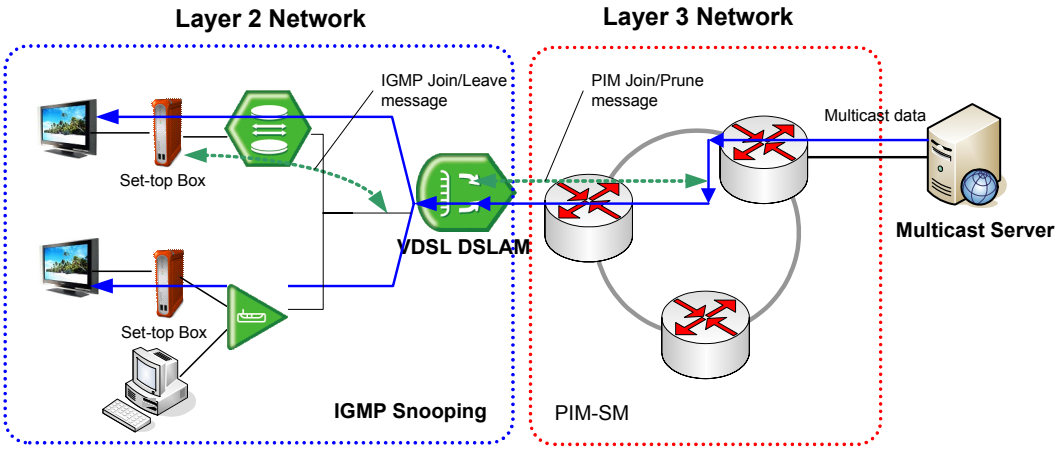


Fig. 9.1 IGMP Snooping in the L2 network

9.1 Multicast Group Membership

The most important implementation of the multicast is the group membership management. The multicast group membership allows a router to know which host is interested in receiving the traffic from a certain multicast group and to forward the multicast traffic corresponding to the group to that host. Even if there is more than one host interested in the group, the router forwards only one copy of the traffic stream to minimize the use of network bandwidth.

Internet Group Management Protocol (IGMP) is a protocol used by routers and hosts to manage the multicast group membership. Using IGMP, hosts express an interest in a certain multicast group, and routers maintain the multicast group membership database by collecting the interests from the hosts.

9.1.1 IGMP Basic

Internet Group Management Protocol (IGMP) manages the host membership in multicast groups. The hosts inform a neighboring multicast router that they are interested in receiving the traffic from a certain multicast group by sending the membership report (join a group). The router then forwards the multicast traffic corresponding to the report to the hosts.

A multicast router called as a querier is responsible for keeping track of the membership state of the multicast groups by sending periodic general query messages to current interested hosts. If there are no responses to the query from the hosts for a given time (leave a group), the router then stops forwarding the traffic. During the above transaction between hosts and routers, they are using IGMP messages to report or query the group membership.

IGMP has three versions that are supported by hosts and routers. The followings are the simple definitions of each version:

- **IGMP Version 1**
  The basic query-response mechanism for the group membership management is introduced. Routers, however, should use the timeout-based mechanism to discover members with no longer interests in the groups since there is no leave process.
- **IGMP Version 2**
  IGMP messages such as leave group and specific-group query are added for the explicit leave process. This process greatly reduces the leave latency compared to IGMP version 1. Unwanted and unnecessary traffic can be constrained much faster.
- **IGMP Version 3**
  The source filtering is supported. That is, hosts now can join a group with specifying including/excluding a set of sources, allowing supporting the source-specific multicast (SSM). It also increases the multicast address capability, and enhances the security from unknown multicast sources.

9.1.1.1 Clearing IGMP Entry

To clear IGMP entries, use the following command.

Command	Mode	Description
clear ip igmp	Enable	Deletes all IGMP entries.
clear ip igmp interface *INTERFACE*		Deletes the IGMP entries learned from a specified interface. INTERFACE: interface name
clear ip igmp group {***** | *A.B.C.D* [*INTERFACE*]}		Deletes IGMP entries in a specified IGMP group. *: all IGMP group A.B.C.D: IGMP group address

9.1.1.2 IGMP Debug

To enable debugging of all IGMP or a specific feature of IGMP, use the following command.

Command	Mode	Description
debug igmp {**all** | **decode** | **encode** | **events** | **fsm** | **tib**}	Enable	Enables IGMP debugging. all: all IGMP decode: IGMP decoding encode: IGMP encoding events: IGMP events fsm: IGMP Finite State Machine (FSM) tib: IGMP Tree Information Base (TIB)
no debug igmp {**all** | **decode** | **encode** | **events** | **fsm** | **tib**}		Disables IGMP debugging.

i Tree Information Base (TIB) is the collection of state at a router that has been created by receiving IGMP messages from local hosts.

9.1.2 IGMP Version 2

In IGMP version 2, the new extensions such as the leave process, election of an IGMP querier, and membership report suppression are added. New IGMP messages, the leave group and group-specific query can be used by hosts to explicitly leave groups, resulting in great reduction of the leave latency.

IGMPv2 Messages

There are three types of IGMPv2 messages of concern to the host-router interaction as shown below:

- **Membership query**
  A multicast router determines if any hosts are listening to a group by sending membership queries. The membership queries have two subtypes.
  – **General query**: This is used to determine if any hosts are listening to any group.
  – **Group-specific query**: This is used to determine if any hosts are listening to a particular group.
- **Version 2 membership report**
  This is used by hosts to join a group (unsolicited) or to respond to membership queries (solicited).
- **Leave group**
  This is used to explicitly leave a group.

IGMPv2 Operation

An IGMP querier is the only router that sends membership query messages for a network segment. In IGMP version 2, the querier is a router with the lowest IP address on the subnet. If the router hears no queries during the timeout period, it becomes the querier.

A host joins multicast groups by sending unsolicited membership report messages indicating its wish to receive multicast traffic for those groups (indicating that the host wants to become a member of the groups).

The querier sends general query messages periodically to discover which multicast groups have members on the attached networks of the router. The messages are addressed to the all-hosts multicast group, which has the address of 224.0.0.1 with a time-to-live (TTL) value of 1. If hosts do not respond to the received query messages for the maximum response time advertised in the messages, a multicast router discovers that no local hosts are members of a multicast group, and then stops forwarding multicast traffic onto the local network from the source for the group.

When hosts respond to membership queries from an IGMP querier, membership reports from the hosts other than the first one are suppressed to avoid increasing the unnecessary traffic. For an IGMP querier, it is sufficient to know that there is at least one interested member for a group on the network segment.

When a host is not interested in receiving the multicast traffic for a particular group any more, it can explicitly leave the group by sending leave group messages. Upon receiving a leave message, a querier then sends out a group-specific query message to determine if there is still any host interested in receiving the traffic. If there is no reply, the querier stops forwarding the multicast traffic.

9.1.2.1 IGMP Static Join

When there are no more group members on a network segment or a host cannot report its group membership using IGMP, multicast traffic is no longer transmitted to the network segment. However, you may want to pull down multicast traffic to a network segment to reduce the time from when an IGMP join request is made to when the requested stream begins arriving at a host, which is called the zapping time.

The IGMP static join feature has been developed to reduce the zapping time by statically creating a virtual host that behaves like a real on a port, even if there is no group member in the group where the port belongs. As a result, a multicast router realizes there is still group member, allowing multicast traffic to be permanently reachable on the group.

To configure the IGMP static join, use the following command.

Command	Mode	Description
ip igmp static-group *A.B.C.D* **vlan** *VLAN* **port** *PORT* [**reporter** *A.B.C.D*]	Global	Configures the IGMP static join. A.B.C.D: IGMP group address VLANS: VLAN ID (1-4094) reporter: host address
no ip igmp static-group		Deletes the configured IGMP static join. *: all addresses
no ip igmp static-group {*A.B.C.D* | **vlan** *VLAN*}		
no ip igmp static-group *A.B.C.D* **vlan** *VLAN* [**port** *PORT*]		
no ip igmp static-group *A.B.C.D* **vlan** *VLAN* **port** *PORT* **reporter** {*A.B.C.D* | *}		

To configure the IGMP static join for a range of IGMP groups by access lists, use the following command.

Command	Mode	Description
ip igmp static-group list {<1-99> | <1300-1999> | WORD} **vlan** *VLAN* **port** *PORT* [**reporter** *A.B.C.D*]	Global	Configures the IGMP static join for a range of IGMP groups by access lists. 1-99: IP standard access list 1300-1999: IP standard access list (expanded) WORD: access list name VLANS: VLAN ID (1-4094) reporter: host address
no ip igmp static-group list {<1-99> | <1300-1999> | WORD}		Deletes the configured IGMP static join for a range of IGMP groups. *: all addresses
no ip igmp static-group list {<1-99> | <1300-1999> | WORD} **vlan** *VLAN* [**port** *PORT*]		
no ip igmp static-group list {<1-99> | <1300-1999> | WORD} **vlan** *VLAN* **port** *PORT* **reporter** {*A.B.C.D* | *}		

To display the IGMP static join group list, use the following command.

Command	Mode	Description
show ip igmp static-group	Enable Global Bridge	Shows the IGMP static join group list. 1-99: IP standard access list 1300-1999: IP standard access list (expanded) WORD: access list name VLANS: VLAN ID (1-4094)
show ip igmp static-group list {<1-99> | <1300-1999> | WORD} [**vlan** *VLAN*]		

If you do not specify the **reporter** option, the IP address configured on the VLAN is used as the source address of the membership report by default. If no IP address is configured on the VLAN, 0.0.0.0 is then used.

This feature only supports an IGMPv2 host; it does not support IGMPv3 host.

9.1.3 IGMP Version 3

IGMP version 3 provides support for the source filtering, which is to receive multicast traffic for a group from specific source addresses, or from except specific source addresses, allowing the Source-Specific Multicast (SSM) model.

The source filtering is implemented by the major revision of the membership report. IGMPv3 membership reports contain two types of the record: current-state and state-change. Each record specifies the information of the filter mode and source list. The report can contain multiple group records, allowing reporting of full current state using fewer packets.

The switch runs IGMPv3 by default, and there are no additional IGMPv3 parameters you need to configure. IGMPv3 snooping features are provided.

IGMPv3 Messages

There are two types of IGMPv3 messages of concern to the host-router interaction as shown below:

- **Membership query**
  A multicast router determines if any hosts are listening to a group by sending membership queries. There are three variants of the membership queries.
  – **General query**: This is used to determine if any hosts are listening to any group.
  – **Group-specific query**: This is used to determine if any hosts are listening to a particular group.
  – **Group-source-specific query**: This is used to determine if any hosts are listening to a particular group and source.
- **Version 3 membership report**
  This is used by hosts to report the current multicast reception state, or changes in the multicast reception state, of their interfaces. IGMPv3 membership reports contain a group record that is a block of fields containing information of the host's membership in a single multicast group on the interface from which the report is sent. A single report may also contain multiple group records. Each group record has one of the following information:

– **Current-state**: This indicates the current filter mode including/excluding the specified multicast address.
– **Filter-mode-change**: This indicates a change from the current filter mode to the other mode.
– **Source-list-change**: This indicates a change allowing/blocking a list of the multicast sources specified in the record.

IGMPv3 Operation

Basically, IGMPv3 has the same join/leave (allow/block in the IGMPv3 terminology) and query-response mechanism as IGMPv2's. Due to the major revision of the membership report, however, leave group messages are not used for the explicit leave process any longer. In IGMPv3 concept, membership reports with state-change records are used to allow or block multicast sources, and those with current-state records are used to respond to membership queries. Membership report suppression feature has been removed for multicast routers to keep track of membership state per host.

9.2 Multicast Functions

The switch provides various multicast functions including Layer 2 multicast forwarding, which allow you to achieve the fully effective and flexible multicast deployment.

This section describes the following features:
- Multicast Forwarding Database
- IGMP Snooping Basic
- IGMPv2 Snooping
- IGMPv3 Snooping
- Displaying IGMP Snooping Information
- Multicast VLAN Registration (MVR)
- IGMP Filtering and Throttling

9.2.1 Multicast Forwarding Database

Internally, the switch forwards the multicast traffic referred to the multicast forwarding database (McFDB). The McFDB maintains multicast forwarding entries collected from multicast protocols and features, such as PIM, IGMP, etc.

The McFDB has the same behavior as the Layer 2 FDB. When certain multicast traffic comes to a port, the switch looks for the forwarding information (the forwarding entry) for the traffic in the McFDB. If the McFDB has the information for the traffic, the switch forwards it to the proper ports. If the McFDB does not have the information for the traffic, the switch learns the information on the McFDB, and then floods it to all ports. If the information is not referred to forward another multicast traffic during the given aging time, it is aged out from the McFDB.

9.2.1.1 Blocking Unknown Multicast Traffic

When certain multicast traffic comes to a port and the McFDB has no forwarding information for the traffic, the multicast traffic is flooded to all ports by default. You can configure the switch not to flood unknown multicast traffic. To configure the switch not to flood unknown multicast traffic, use the following command.

Command	Mode	Description
ip unknown-multicast [**port** *PORTS*] **block**	Global	Configures the switch not to flood unknown multicast traffic.
no ip unknown-multicast [**port** *PORTS*] **block**		Configures the switch to flood unknown multicast traffic. (default)

This command should not be used for the ports to which a multicast router is attached!

9.2.1.2 Forwarding Entry Aging

To specify the aging time for forwarding entries on the McFDB, use the following command.

Command	Mode	Description
ip mcfdb aging-time <10-10000000>	Global	Specifies the aging time for forwarding entries on the McFDB. 10-10000000: aging time (default: 300)
no ip mcfdb aging-time		Deletes the specified aging time for forwarding entries.

To specify the maximum number of forwarding entries on the McFDB, use the following command.

Command	Mode	Description
ip mcfdb aging-limit <256-65535>	Global	Specifies the maximum number of forwarding entries on the McFDB. 256-65535: number of entries (default: 5000)
no ip mcfdb aging-limit		Deletes the specified maximum number of forwarding entries.

9.2.1.3 Displaying McFDB Information

To display McFDB information, use the following command.

Command	Mode	Description
show ip mcfdb	Enable Global Bridge	Shows the current aging time and maximum number of forwarding entries.
show ip mcfdb aging-entry [**vlan** *VLAN* | **group** *A.B.C.D*] [**mac-based** | **detail**]		Shows the current forwarding entries. VLAN: VLAN ID (1-4094) A.B.C.D: multicast group address mac-based: lists entries on a MAC address basis

To clear multicast forwarding entries, use the following command.

Command	Mode	Description
clear ip mcfdb [* | **vlan** *VLAN*]	Enable Global	Clears multicast forwarding entries. *: all forwarding entries VLAN: VLAN ID (1-4094)
clear ip mcfdb vlan *VLAN* **group** *A.B.C.D* **source** *A.B.C.D*		Clears a specified forwarding entry. group: multicast group source: multicast source

9.2.2 IGMP Snooping Basic

Layer 2 switches normally flood multicast traffic within the broadcast domain, since it has no entry in the Layer 2 forwarding table for the destination address. Multicast addresses never appear as source addresses, therefore the switch cannot dynamically learn multicast addresses. This multicast flooding causes unnecessary bandwidth usage and discarding unwanted frames on those nodes which did not want to receive the multicast transmission. To avoid such flooding, IGMP snooping feature has been developed.

The purpose of IGMP snooping is to constrain the flooding of multicast traffic at Layer 2. IGMP snooping, as implied by the name, allows a switch to snoop the IGMP transaction between hosts and routers, and maintains the multicast forwarding table which contains the information acquired by the snooping. When the switch receives a join request from a host for a particular multicast group, the switch then adds a port number connected to the host and a destination multicast group to the forwarding table entry; when the switch receives a leave message from a host, it removes the entry from the table.

By maintaining this multicast forwarding table, the switch dynamically forward multicast traffic only to those interfaces that want to receive it as nominal unicast forwarding does.

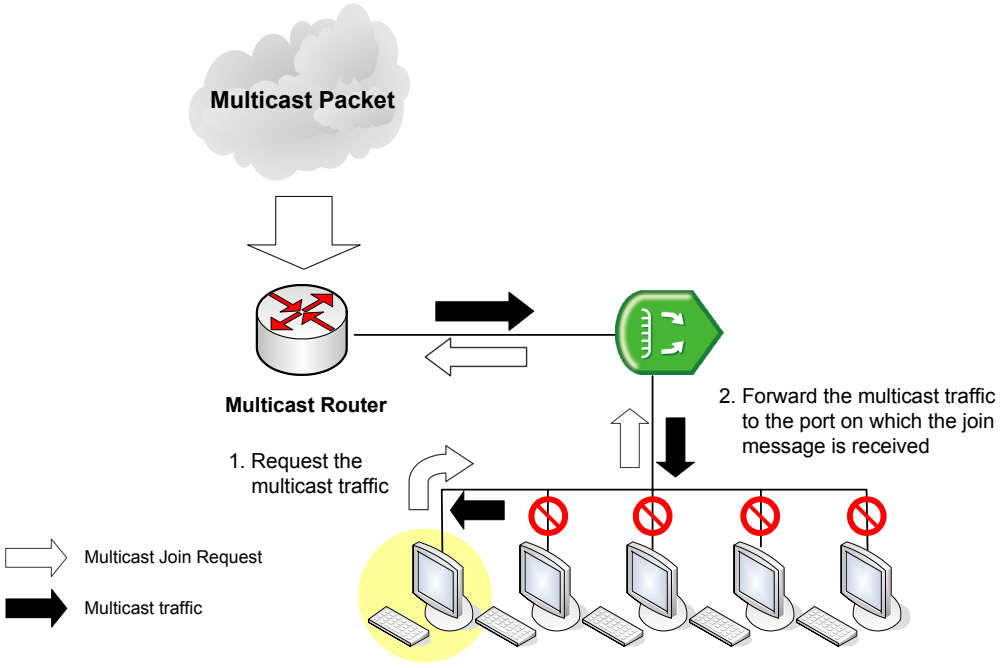

Multicast Packet
Multicast Router
1. Request the multicast traffic
2. Forward the multicast traffic to the port on which the join message is received
Multicast Join Request
Multicast traffic

Fig. 9.2 IGMP Snooping

9.2.2.1 Enabling IGMP Snooping

The switch supports forwarding tables for IGMP snooping on a VLAN basis. You can enable IGMP snooping globally or on each VLAN respectively. By default, IGMP snooping is globally disabled.

To enable IGMP snooping, use the following command.

Command	Mode	Description
ip igmp snooping	Global	Enables IGMP snooping globally.
ip igmp snooping vlan *VLANS*		Enables IGMP snooping on a VLAN. VLANS: VLAN ID (1-4094)

To disable IGMP snooping, use the following command.

Command	Mode	Description
no ip igmp snooping	Global	Disables IGMP snooping globally.
no ip igmp snooping vlan *VLANS*		Disables IGMP snooping on a VLAN. VLANS: VLAN ID (1-4094)

9.2.2.2 IGMP Snooping Version

The membership reports sent to the multicast router are sent based on the IGMP snooping version of the interface. If you statically specify the version on a certain interface, the reports are always sent out only with the specified version. If you do not statically specify the version, and a version 1 query is received on the interface, the interface dynamically sends out a version 1 report. If no version 1 query is received on the interface for the version 1 router present timeout period (400 seconds), the interface version goes back to its default value (3).

To specify the IGMP snooping version, use the following command.

Command	Mode	Description
ip igmp snooping version <1-3>	Global	Configures the IGMP snooping version globally. 1-3: IGMP snooping version (default: 3)
ip igmp snooping vlan *VLANS* **version** <1-3>		Configures the IGMP snooping version on a VLAN interface. VLANS: VLAN ID (1-4094)

To delete the specified IGMP snooping version, use the following command.

Command	Mode	Description
no ip igmp snooping version	Global	Deletes the specified IGMP snooping version.
no ip igmp snooping vlan *VLANS* **version**		

9.2.2.3 IGMP Snooping Robustness Value

The robustness variable allows tuning for the expected packet loss on a network. If a network is expected to be lossy, the robustness variable may be increased. When receiving the query message that contains a certain robustness variable from an IGMP snooping querier, a host returns the report message as many as the specified robustness variable.

To configure the robustness variable, use the following command.

Command	Mode	Description
ip igmp snooping robustness-variable <1-7>	Global	Configures the robustness variable. (default: 2)
ip igmp snooping vlan *VLANS* **robustness-variable** <1-7>		Configures the robustness variable on a VLAN. VLANS: VLAN ID (1-4094)

To delete a specified robustness variable, use the following command.

Command	Mode	Description
no ip igmp snooping robustness-variable	Global	Deletes a specified robustness variable.
no ip igmp snooping vlan *VLANS* **robustness-variable**		

9.2.3 IGMPv2 Snooping

9.2.3.1 IGMP Snooping Querier Configuration

IGMP snooping querier should be used to support IGMP snooping in a VLAN where PIM and IGMP are not configured.

When the IGMP snooping querier is enabled, the IGMP snooping querier sends out periodic general queries that trigger membership report messages from a host that wants to receive multicast traffic. The IGMP snooping querier listens to these membership reports to establish appropriate forwarding.

Enabling IGMP Snooping Querier

To enable the IGMP snooping querier, use the following command.

Command	Mode	Description
ip igmp snooping querier [**address** *A.B.C.D*]	Global	Enables the IGMP snooping querier globally. A.B.C.D: source address of IGMP snooping query
ip igmp snooping vlan *VLANS* **querier** [**address** *A.B.C.D*]		Enables the IGMP snooping querier on a VLAN. VLANS: VLAN ID (1-4094)

To disable the IGMP snooping querier, use the following command.

Command	Mode	Description
no ip igmp snooping querier [**address**]	Global	Disables the IGMP snooping querier. address: source address of IGMP snooping query
no ip igmp snooping vlan *VLANS* **querier** [**address**]		

i If you do not specify a source address of an IGMP snooping query, the IP address configured on the VLAN is used as the source address by default. If no IP address is configured on the VLAN, 0.0.0.0 is then used.

IGMP Snooping Query Interval

An IGMP snooping querier periodically sends general query messages to trigger membership report messages from a host that wants to receive IP multicast traffic.

To specify an interval to send general query messages, use the following command.

Command	Mode	Description
ip igmp snooping querier query-interval <1-1800>	Global	Specifies an IGMP snooping query interval in the unit of second. 1-1800: query interval (default: 125)
ip igmp snooping vlan *VLANS* **querier query-interval** <1-1800>		Specifies an IGMP snooping query interval on a VLAN. VLANS: VLAN ID (1-4094)

To delete a specified interval to send general query messages, use the following command.

Command	Mode	Description
no ip igmp snooping querier query-interval	Global	Disables a specified IGMP snooping query interval.
no ip igmp snooping vlan *VLANS* **querier query-interval**		

IGMP Snooping Query Response Time

Membership query messages include the maximum query response time field. This field specifies the maximum time allowed before sending a responding report. The maximum query response time allows a router to quickly detect that there are no more hosts interested in receiving multicast traffic.

To specify a maximum query response time advertised in general query messages, use the following command.

Command	Mode	Description
ip igmp snooping querier max-response-time <1-25>	Global	Specifies a maximum query response time. 1-25: maximum response time (default: 10 seconds)
ip igmp snooping vlan *VLANS* **querier max-response-time** <1-25>		Specifies a maximum query response time. VLANS: VLAN ID (1-4094)

To delete a specified maximum query response time, use the following command.

Command	Mode	Description
no ip igmp snooping querier max-response-time	Global	Deletes a specified maximum query response time.
no ip igmp snooping vlan *VLANS* **querier max-response-time**		

Displaying IGMP Snooping Querier Information

To display IGMP querier information and configured parameters, use the following command.

Command	Mode	Description
show ip igmp snooping [**vlan** *VLANS*] **querier** [**detail**]	Enable Global Bridge	Shows IGMP querier information and configured parameters.

9.2.3.2 IGMP Snooping Last Member Query Interval

Upon receiving a leave message, a switch with IGMP snooping then sends out a group-specific (IGMPv2) or group-source-specific query (IGMPv3) message to determine if there is still any host interested in receiving the traffic. If there is no reply, the switch stops forwarding the multicast traffic. However, IGMP messages may get lost for various reasons, so you can specify an interval to send query messages.

To specify an interval to send group-specific or group-source-specific query messages, use the following command.

Command	Mode	Description
ip igmp snooping last-member-query-interval <100-10000>	Global	Specifies a last member query interval. 100-10000: last member query interval (default: 1000 milliseconds)
ip igmp snooping vlan *VLANS* **last-member-query-interval** <100-10000>		Specifies a last member query interval. VLANS: VLAN ID (1-4094)

To delete a specified an interval to send group-specific or group-source-specific query messages, use the following command.

Command	Mode	Description
no ip igmp snooping last-member-query-interval	Global	Deletes a specified last member query interval.
no ip igmp snooping vlan *VLANS* **last-member-query-interval**		

9.2.3.3 IGMP Snooping Immediate Leave

Normally, an IGMP snooping querier sends a group-specific or group-source-specific query message upon receipt of a leave message from a host. If you want to set a leave latency as 0 (zero), you can omit the querying procedure. When the querying procedure is omitted, the switch immediately removes the entry from the forwarding table for that VLAN, and informs the multicast router.

To enable the IGMP snooping immediate leave, use the following command.

Command	Mode	Description
ip igmp snooping immediate-leave	Global	Enables the IGMP snooping immediate leave globally.
ip igmp snooping port *PORTS* **immediate-leave**		Enables the IGMP snooping immediate leave on a port. PORTS: port number
ip igmp snooping vlan *VLANS* **immediate-leave**		Enables the IGMP snooping immediate leave on a VLAN. VLANS: VLAN ID (1-4094)

To disable the IGMP snooping immediate leave, use the following command.

Command	Mode	Description
no ip igmp snooping immediate-leave	Global	Disables the IGMP snooping immediate leave.
no ip igmp snooping port *PORTS* **immediate-leave**		
no ip igmp snooping vlan *VLANS* **immediate-leave**		

Use this command with the explicit host tracking feature (see Section 9.2.3.6). If you don’t, when there is more than one IGMP host belonging to a VLAN, and a certain host sends a leave group message, the switch will remove all host entries on the forwarding table from the VLAN. The switch will lose contact with the hosts that should remain in the forwarding table until they send join requests in response to the switch's next general query message.

9.2.3.4 IGMP Snooping Report Suppression

If an IGMP querier sends general query messages, and hosts are still interested in the multicast traffic, the hosts should return membership report messages. For a multicast router, however, it is sufficient to know that there is at least one interested member for a group on the network segment. Responding a membership report per each of group members may unnecessarily increase the traffic on the network; only one report per group is enough.

When the IGMP snooping report suppression is enabled, a switch suppresses membership reports from hosts other than the first one, allowing the switch to forward only one membership report in response to a general query from a multicast router.

To enable the IGMP snooping report suppression, use the following command.

Command	Mode	Description
ip igmp snooping report-suppression	Global	Enables the IGMP snooping report suppression globally.
ip igmp snooping vlan *VLANS* **report-suppression**		Enables the IGMP snooping report suppression on a VLAN. VLANS: VLAN ID (1-4094)

To disable the IGMP snooping report suppression, use the following command.

Command	Mode	Description
no ip igmp snooping report-suppression	Global	Disables the IGMP snooping report suppression.
no ip igmp snooping vlan *VLANS* **report-suppression**		

The IGMP snooping report suppression is supported only IGMPv1 and IGMPv2 reports. In case of an IGMPv3 report, a single membership report can contain the information for all the groups which a host is interested in. Thus, there is no need for the report suppression since the number of reports would be generally equal to the number of hosts only.

9.2.3.5 IGMP Snooping S-Query Report Agency

If IGMP snooping switch receives IGMP group-specific query messages from the multicast router, it just floods them into all of its ports. The hosts received the group-specific queries send the report messages according to their IGMP membership status. However, this switch is enabled as IGMP snooping S-Query report agency, the group-specific queries are not sent downstream. When the switch receives a group-specific query, the switch terminates the query and sends an IGMP report if there is a receiver for the group.

To enable IGMP snooping S-Query Report Agency, use the following command.

Command	Mode	Description
ip igmp snooping s-query-report-agency	Global	Enables IGMP snooping s-query-report agency.

To disable IGMP snooping S-Query Report Agency, use the following command.

Command	Mode	Description
no ip igmp snooping s-query-report-agency	Global	Disables IGMP snooping s-query-report agency.

9.2.3.6 Explicit Host Tracking

Explicit host tracking is one of the important IGMP snooping features. It has the ability to build the explicit tracking database by collecting the host information via the membership reports sent by hosts. This database is used for the immediate leave for IGMPv2 hosts, the immediate block for IGMPv3 hosts, and IGMP statistics collection.

To enable explicit host tracking, use the following command.

Command	Mode	Description
ip igmp snooping explicit-tracking	Global	Enables explicit host tracking globally.
ip igmp snooping vlan *VLANS* **explicit-tracking**		Enables explicit host tracking on a VLAN. VLANS: VLAN ID (1-4094)

To disable explicit host tracking, use the following command.

Command	Mode	Description
no ip igmp snooping explicit-tracking	Global	Disables explicit host tracking globally.
no ip igmp snooping vlan *VLANS* **explicit-tracking**		Disables explicit host tracking on a VLAN. VLANS: VLAN ID (1-4094)

You can also restrict the number of hosts on a port for the switch performance and enhanced security.

To specify the maximum number of hosts on a port, use the following command.

Command	Mode	Description
ip igmp snooping explicit-tracking max-hosts port *PORTS* **count** <1-256>	Global	Specifies the maximum number of hosts on a port. PORTS: port number 1-256: maximum number of hosts (default: 256)
no ip igmp snooping explicit-tracking max-hosts port *PORTS*		Deletes the specified maximum number of hosts

To display the explicit tracking information, use the following command.

Command	Mode	Description
show ip igmp snooping explicit-tracking	Enable Global Bridge	Shows the explicit host tracking information globally.
show ip igmp snooping explicit-tracking vlan *VLANS*		Shows the explicit host tracking information per VLAN. VLANS: VLAN ID (1-4094)
show ip igmp snooping explicit-tracking port *PORTS*		Shows the explicit host tracking information per port. PORTS: port number
show ip igmp snooping explicit-tracking group *A.B.C.D*		Shows the explicit host tracking information per group. A.B.C.D: multicast group address

i Explicit host tracking is enabled by default.

9.2.3.7 Multicast Router Port Configuration

The multicast router port is the port which is directly connected to a multicast router. A switch adds multicast router ports to the forwarding table to forward membership reports only to those ports. Multicast router ports can be statically specified or dynamically learned by incoming IGMP queries and PIM hello packets.

Static Multicast Router Port

You can statically configure Layer 2 port as the multicast router port which is directly connected to a multicast router, allowing a static connection to a multicast router.

To specify a multicast router port, use the following command.

Command	Mode	Description
ip igmp snooping mrouter port {*PORTS* | **cpu**}	Global	Specifies a multicast router port globally. PORTS: port number cpu: CPU port
ip igmp snooping vlan *VLANS* **mrouter port** {*PORTS* | **cpu**}		Specifies a multicast router port on a VLAN. VLANS: VLAN ID (1-4094)

To delete a specified multicast router port, use the following command.

Command	Mode	Description
no ip igmp snooping mrouter port {*PORTS* | **cpu**}	Global	Deletes a specified multicast router port.
no ip igmp snooping vlan *VLANS* **mrouter port** {*PORTS* | **cpu**}		

Multicast Router Port Learning

Multicast router ports are added to the forwarding table for every Layer 2 multicast entry. The switch dynamically learns those ports through snooping on PIM hello packets.

To enable the switch to learn multicast router ports through PIM hello packets, use the following command.

Command	Mode	Description
ip igmp snooping mrouter learn pim	Global	Enables to learn multicast router ports through PIM hello packets globally.
ip igmp snooping vlan *VLANS* **mrouter learn pim**		Enables to learn multicast router ports through PIM hello packets on a VLAN. VLANS: VLAN ID (1-4094)

Multicast Router Port Forwarding

The multicast traffic should be forwarded to IGMP snooping membership ports and multicast router ports because the multicast router needs to receive muticast source information. To enable the switch to forward the traffic to multicast router ports, use the following command.

Command	Mode	Description
ip multicast mrouter-pass-through	Global	Enables to forward multicast traffic to the multicast router ports.
no ip multicast mrouter-pass-through		Disables to forward multicast traffic to the multicast router ports.

To disable the switch to learn multicast router ports through PIM hello packets, use the following command.

Command	Mode	Description
no ip igmp snooping mrouter learn pim	Global	Disables to learn multicast router ports through PIM hello packets.
no ip igmp snooping vlan *VLANS* **mrouter learn pim**		

Displaying Multicast Router Port

To display a current multicast router port for IGMP snooping, use the following command.

Command	Mode	Description
show ip igmp snooping mrouter	Enable Global Bridge	Shows a current multicast router port for IGMP snooping globally.
show ip igmp snooping vlan *VLANS* **mrouter**		Shows a current multicast router port for IGMP snooping on a specified VLAN. VLANS: VLAN ID (1-4094)

9.2.3.8 TCN Multicast Flooding

When a network topology change occurs, the protocols for a link layer topology – such as spanning tree protocol (STP), Ethernet ring protection (ERP), etc – notify switches in the topology using a topology change notification (TCN).

When TCN is received, the switch where an IGMP snooping is running will flood multicast traffic to all ports in a VLAN, since a network topology change in a VLAN may invalidate previously learned IGMP snooping information. However, this flooding behavior is not desirable if the switch has many ports that are subscribed to different groups. The traffic could exceed the capacity of the link between the switch and the end host, resulting in packet loss. Thus, a period of multicast flooding needs to be controlled to solve such a problem.

Enabling TCN Multicast Flooding

To enable the switch to flood multicast traffic when TCN is received, use the following command.

Command	Mode	Description
ip igmp snooping tcn flood	Global	Enables the switch to flood multicast traffic when TCN is received.
ip igmp snooping tcn vlan *VLANS* **flood**		Enables the switch to flood multicast traffic on a VLAN when TCN is received. VLANS: VLAN ID (1-4094)

To disable the switch to flood multicast traffic when TCN is received, use the following command.

Command	Mode	Description
no ip igmp snooping tcn flood	Global	Disables the switch to flood multicast traffic when TCN is received
no ip igmp snooping tcn vlan *VLANS* **flood**		

TCN Flooding Suppression

When TCN is received, the switch where an IGMP snooping is running will flood multicast traffic to all ports until receiving two general queries, or during two general query intervals by default. You can also configure the switch to stop multicast flooding according to a specified query count or query interval.

To specify a query count to stop multicast flooding, use the following command.

Command	Mode	Description
ip igmp snooping tcn flood query count <1-10>	Global	Specifies a query count to stop multicast flooding. 1-10: query count value (default: 2)
no ip igmp snooping tcn flood query count		Deletes a specified query count to stop multicast flooding.

To specify a query interval to stop multicast flooding, use the following command.

Command	Mode	Description
ip igmp snooping tcn flood query interval <1-1800>	Global	Specifies a query interval to stop multicast flooding in the unit of second. An actual stop-flooding interval is calculated by (query count) x (query interval). 1-1800: query interval value (default: 125)
no ip igmp snooping tcn flood query interval		Deletes a specified query interval to stop multicast flooding.

TCN Flooding Query Solicitation

Typically, if a network topology change occurs, the spanning tree root switch issues a query solicitation which is actually a global leave message with the group address 0.0.0.0. When a multicast router receives this solicitation, it immediately sends out IGMP general queries to hosts, allowing the fast convergence. You can direct the switch where an IGMP snooping is running to send a query solicitation when TCN is received.

To enable/disable the switch to send a query solicitation when TCN is received, use the following command.

Command	Mode	Description
ip igmp snooping tcn query solicit [**address** *A.B.C.D*]	Global	Enables the switch to send a query solicitation when TCN is received. address: source IP address for query solicitation
no ip igmp snooping tcn query solicit [**address**]		Disables the switch to send a query solicitation when TCN is received.

9.2.4 IGMPv3 Snooping

Immediate Block

IGMPv3 immediate block feature allows a host to block sources with the block latency, 0 (zero) by referring to the explicit tracking database. When receiving a membership report with the state-change record from a host that is no longer interested in receiving multicast traffic from a certain source, the switch compares the source list for the host in the explicit tracking database with the source list in the received membership report. If both are matching, the switch removes the source entry from the list in the database, and stops forwarding the multicast traffic to the host; a group-source-specific query message is not needed for the membership leave process.

To enable IGMPv3 immediate block, use the following command.

Command	Mode	Description
ip igmp snooping immediate-block	Global	Enables immediate block globally.
ip igmp snooping vlan *VLANS* **immediate-block**		Enables immediate block on a VLAN. VLANS: VLAN ID (1-4094)

To disable IGMPv3 immediate block, use the following command.

Command	Mode	Description
no ip igmp snooping immediate-block	Global	Disables immediate block globally.
no ip igmp snooping vlan *VLANS* **immediate-block**		Disables immediate block on a VLAN. VLANS: VLAN ID (1-4094)

i IGMPv3 immediate block is enabled by default.

9.2.5 Displaying IGMP Snooping Information

To display a current IGMP snooping configuration, use the following command.

Command	Mode	Description
show ip igmp snooping [**vlan** *VLANS*]	Enable Global Bridge	Shows a current IGMP snooping configuration. VLAN: VLAN ID (1-4094)

To display the IGMP snooping table, use the following command.

Command	Mode	Description
show ip igmp snooping groups [*A.B.C.D* | **mac-based**]	Enable Global Bridge	Shows the IGMP snooping table globally. mac-based: lists groups on a MAC address basis.
show ip igmp snooping groups port {*PORTS* | **cpu**} [**mac-based**]		Shows the IGMP snooping table per port. PORTS: port number
show ip igmp snooping groups vlan *VLANS* [**mac-based**]		Shows the IGMP snooping table per VLAN. VLANS: VLAN ID (1-4094)

To display the collected IGMP snooping statistics, use the following command.

Command	Mode	Description
show ip igmp snooping stats port {*PORTS* | **cpu**}	Enable Global	Shows the collected IGMP snooping statistics. PORTS: port number

To clear the collected IGMP snooping statistics, use the following command.

Command	Mode	Description
clear ip igmp snooping stats port [*PORTS* | **cpu**]	Enable Global	Clears the collected IGMP snooping statistics PORTS: port number

9.2.6 Multicast VLAN Registration (MVR)

Multicast VLAN registration (MVR) is designed for applications using multicast traffic across an Ethernet network. MVR allows a multicast VLAN to be shared among subscribers remaining in separate VLANs on the network. It guarantees the Layer 2 multicast flooding instead of the forwarding via Layer 3 multicast, allowing to flood multicast streams in the multicast VLAN, but to isolate the streams from the subscriber VLANs for bandwidth and security reasons. This improves bandwidth utilization and simplifies multicast group management.

MVR also provides the fast convergence for topology changes in the Ethernet ring-based service provider network with STP and IGMP snooping TCN, guaranteeing stable multicast services.

MVR implemented for the switch has the following restrictions, so you must keep in mind those, before configuring MVR.

- All receiver ports must belong to the both subscriber and multicast VLANs as untagged.
- IGMP snooping must be enabled before enabling MVR.
- A single MVR group address cannot belong to more than two groups.
- MVR and multicast routing cannot be enabled together.
- MVR only supports IGMPv2.

9.2.6.1 Enabling MVR

To enable MVR on the system, use the following command.

Command	Mode	Description
mvr	Global	Enables MVR.
no mvr		Disables MVR.

9.2.6.2 MVR Group

To configure MVR, you need to specify an MVR group and group address. If you specify several MVR groups, IGMP packets from the receiver ports are sent to the source ports belonging to the corresponding MVR group according to the group address specified in the packets.

To specify an MVR group and group address, use the following command.

Command	Mode	Description
mvr vlan *VLAN* **group** *A.B.C.D*	Global	Specifies an MVR group and group address. VLAN: VLAN ID (1-4094) A.B.C.D: IGMP group address
no mvr vlan *VLAN* **group** *A.B.C.D*		Deletes a specified MVR group and group address.

9.2.6.3 Source/Receiver Port

You need to specify the source and receiver ports for MVR. The followings are the definitions for the ports.

- **Source Port**
  This is connected to multicast routers or sources as an uplink port, which receives and sends the multicast traffic. Subscribers cannot be directly connected to source ports. All source ports belong to the multicast VLAN as tagged.
- **Receiver Port**
  This is directly connected to subscribers as a subscriber port, which should only receive the multicast traffic. All receiver ports must belong to the both subscriber and multicast VLANs as untagged for implementation reasons.

To specify a port as the source or receiver port, use the following command.

Command	Mode	Description
mvr port *PORTS* **type** {**receiver** | **source**}	Global	Specifies an MVR port. PORTS: port number
no mvr port *PORTS*		Deletes a specified MVR port.

9.2.6.4 MVR Helper Address

When being in a different network from an MVR group's, a multicast router sends the multicast traffic to each MVR group. In such an environment, when an IGMP packet from a subscriber is transmitted to the multicast router via the MVR group (multicast VLAN interface), the source address of the IGMP packet may not match the network address of the MVR group. In this case, the multicast router normally discards the IGMP packet. To avoid this behavior, you can configure the switch to replace the source address with a specified helper address. The helper address must belong to the MVR group's network.

To specify an MVR helper address to replace a source address of an IGMP packet, use the following command.

Command	Mode	Description
mvr vlan *VLAN* **helper** *A.B.C.D*	Global	Specifies an MVR helper address. VLAN: VLAN ID (1-4094) A.B.C.D: helper address
no mvr vlan *VLAN* **helper**		Deletes a specified MVR helper address.

9.2.6.5 Displaying MVR Configuration

To display an MVR configuration, use the following command.

Command	Mode	Description
show mvr	Enable Global	Shows an MVR configuration.
show mvr port		
show mvr vlan *VLANS*		

9.2.7 IGMP Filtering and Throttling

IGMP filtering and throttling control the distribution of multicast services on each port. IGMP filtering controls which multicast groups a host on a port can join by associating an IGMP profile that contains one or more IGMP groups and specifies whether an access to the group is permitted or denied with a port. For this operation, configuring the IGMP profile is needed before configuring the IGMP filtering. IGMP throttling limits the maximum number of IGMP groups that a host on a port can join.

Note that both IGMP filtering and throttling control only membership reports (join messages) from a host, and do not control multicast streams.

9.2.7.1 IGMP Filtering

Creating IGMP Profile

You can configure an IGMP profile for IGMP filtering in *IGMP Profile Configuration* mode. The system prompt will be changed from SWITCH(config)# to SWITCH(config-igmp-profile[N])#.

To create/modify an IGMP profile, use the following command.

Command	Mode	Description
ip igmp profile <1-2147483647>	Global	Creates/modifies an IGMP profile. 1-2147483647: IGMP profile number
no ip igmp profile <1-2147483647>		Deletes a created IGMP profile.

IGMP Group Range

To specify an IGMP group range to apply to IGMP filtering, use the following command.

Command	Mode	Description
range *A.B.C.D* [*A.B.C.D*]	IGMP Profile	Specifies a range of IGMP groups. A.B.C.D: low multicast address A.B.C.D: high multicast address
no range *A.B.C.D* [*A.B.C.D*]		Deletes a specified range of IGMP groups.

i A single IGMP group address is also possible.

IGMP Filtering Policy

To specify an action to permit or deny an access to an IGMP group range, use the following command.

Command	Mode	Description
{**permit** | **deny**}	IGMP Profile	Specifies an action for an IGMP group range.

Enabling IGMP Filtering

To enable IGMP filtering for a port, a configured IGMP profile needs to be applied to the port.

To apply an IGMP profile to ports to enable IGMP filtering, use the following command.

Command	Mode	Description
ip igmp filter port *PORTS* **profile** <1-2147483647>	Global	Applies an IGMP profile to ports PORTS: port number 1-2147483647: IGMP profile number
no ip igmp filter port *PORTS*		Releases an applied IGMP profile.

Before enabling IGMP filtering, please keep in mind the following restrictions.

- Plural IGMP profiles cannot be applied to a single port.
- IGMP snooping must be enabled before enabling IGMP filtering.
- To delete a created IGMP profile, all ports where the profile applied must be released.
- IGMP filtering only supports IGMPv2.

By the following command, this switch can permit or deny the IGMP packets by referring to its DHCP snooping binding table. This reference enables the system to permit IGMP messages only when the source IP address and MAC address of host have identified from the DHCP snooping binding table.

To permit/discard IGMP packets for the hosts authorized by the DHCP snooping, use the following command.

Command	Mode	Description
ip igmp filter port *PORTS* **permit dhcp-snoop-binding**	Global	Adds the entry to IGMP snooping table when it exists on the DHCP snooping binding table.
no ip igmp filter port *PORTS* **permit dhcp-snoop-binding**		Adds the entry to IGMP snooping table irrespective of DHCP snooping binding table.

To allow or discard IGMP messages by message type on a port, use the following command.

Command	Mode	Description
ip igmp filter port *PORTS* **packet –type** {**reportv1** | **reportv2** | **reportv3** | **query** | **leave** | **all**}	Global	Filters the specified IGMP messages on a port.
no ip igmp filter port *PORTS* **packet –type** {**reportv1** | **reportv2** | **reportv3** | **query** | **leave** | **all**}		Disables filtering the specified IGMP messages on a port.

9.2.7.2 IGMP Throttling

You can configure the maximum number of multicast groups that a host on a port can join. To specify the maximum number of IGMP groups per port, use the following command.

Command	Mode	Description
ip igmp max-groups port *PORTS* **count** <1-2147483647>	Global	Specifies the maximum number of IGMP groups that hosts on specific port can join. PORTS: port number 1-2147483647: number of IGMP groups
ip igmp max-groups port all count <1-2147483647>		Specifies the maximum number of IGMP groups that hosts on all ports can join.
no ip igmp max-groups port {*PORTS* | **all**}		Deletes a specified maximum number of IGMP groups.

To specify the maximum number of IGMP groups for the system, use the following command.

Command	Mode	Description
ip igmp max-groups system count <1-2147483647>	Global	Specifies the maximum number of IGMP groups for the system. 1-2147483647: number of IGMP groups
no ip igmp max-groups system		Deletes a specified maximum number of IGMP groups.

9.2.7.3 Displaying IGMP Filtering and Throttling

To display a configuration for IGMP filtering and throttling, use the following command.

Command	Mode	Description
show ip igmp filter [**port** *PORTS*]	Enable Global Bridge	Shows a configuration for IGMP filtering and throttling. PORTS: port number

To display existing IGMP profiles, use the following command.

Command	Mode	Description
show ip igmp profile [<1-2147483647>]	Enable Global Bridge	Shows existing IGMP profiles. 1-2147483647: IGMP profile number

9.2.8 Multicast-Source Trust Port

Any port of this switch can be specified as a multicast-source trust port which is registered in the multicast forwarding table. Only multicast-source trust ports can be received the multicast traffic.

However, the reserved multicast packets should be sent to CPU even if these packets pass through a multicast-source trust port. This feature helps the switch to distinguish be-

tween general traffic receivers and multicast traffic receivers, and is a more efficient use of system resources because it sends the multicast traffic to specic hosts which want to receive the traffic.

To configure a specified port as a multicast-source trust port, use the following command.

Command	Mode	Description
ip multicast-source trust port *PORTS*	Global	Specifies multicast-source trust ports
no ip multicast-source trust port *PORTS*		Deletes the configured multicast-source trust ports

10 System Software Upgrade

10.1 General Upgrade

For the system enhancement and stability, new system software may be released. Using this software, the switch can be upgraded without any hardware change. You can simply upgrade your system software with the provided upgrade functionality via the CLI.

The switch supports the dual system software functionality, which you can select applicable system software stored in the system according to various reasons such as the system compatibility or stability.

To upgrade the system software of the switch, use the following command.

Command	Mode	Description
copy {**ftp** | **tftp**} **os download** {**os1** | **os2**}	Enable	Upgrades the system software of the switch via FTP or TFTP. os1 | os2: the area where the system software is stored

To upgrade the system software, FTP or TFTP server must be set up first! Using the **copy** command, the system will download the new system software from the server.

To reflect the downloaded system software, the system must restart using the **reload** command! For more information, see Section 4.1.10.1.

The following is an example of upgrading the system software stored in **os1**.

```
SWITCH# copy ftp os download os1
 To exit : press Ctrl+D
--------------------------------------
IP address or name of remote host (FTP): 10.100.158.144
Download File Name : V5924C-R.5.01.x
User Name : admin
Password:
Hash mark printing on (1024 bytes/hash mark).
Downloading NOS ....
################################################################################
################################################################################
################################################################################
################################################################################
################################################################################
################################################################################

(Omitted)

################################################################################
################################################################################
################################################################################
################################################################################
################################################################################
################################################################################
################################################################################
############################################################
13661792 bytes download OK.
```

```
SWITCH# show flash

Flash Information(Bytes)

 Area                          total          used          free
 ------------------------------------------------------------------
 OS1(default)(running)     16777216      13661822       3115394     5.01 #3001
 OS2                       16777216      13661428       3115788     4.07 #1008
 CONFIG                     4194304        663552       3530752
 ------------------------------------------------------------------
 Total                     37748736      27986802       9761934
SWITCH# reload
Do you want to save the system configuration? [y/n]y
Do you want to reload the system? [y/n]y

Broadcast message from admin (ttyp0) (Fri Aug 18 15:15:41 2006 +0000):

The system is going down for reboot NOW!
```

10.2 Boot Mode Upgrade

In case that you cannot upgrade the system software with the general upgrade procedure, you can upgrade it with the boot mode upgrade procedure. Before the boot mode upgrade, please keep in mind the following restrictions.

- A terminal must be connected to the system via the console interface. To open the boot mode, you should press <**S**> key when the boot logo is shown up.
- The boot mode upgrade supports TFTP only. You must set up TFTP server before upgrading the system software in the boot mode.
- In the boot mode, the only interface you can use is MGMT interface. So the system must be connected to the network via the MGMT interface.
- All you configures in the boot mode is limited to the boot mode only!

To upgrade the system software in the boot mode, perform the following step-by-step instruction:

Step 1
To open the boot mode, press <**S**> key when the boot logo is shown up.

```
************************************************************
*                                                          *
*                 Boot Loader Version 5.43                 *
*                       SMC networks Inc.                  *
*                                                          *
************************************************************
Press 's' key to go to Boot Mode:  0
Boot>
```

Step 2
To enable the MGMT interface to communicate with TFTP server, you need to configure a proper IP address, subnet mask and gateway on the interface.

To configure an IP address, use the following command.

Command	Mode	Description
ip *A.B.C.D*	Boot	Configures an IP address.
ip		Shows a currently configured IP address.

To configure a subnet mask, use the following command.

Command	Mode	Description
netmask *A.B.C.D*	Boot	Configures a subnet mask. (e.g. 255.255.255.0)
netmask		Shows a currently configured subnet mask.

To configure a default gateway, use the following command.

Command	Mode	Description
gateway *A.B.C.D*	Boot	Configures a default gateway.
gateway		Shows a currently configured default gateway.

To display a configured IP address, subnet mask and gateway, use the following command.

Command	Mode	Description
show	Boot	Shows a currently configured IP address, subnet mask and gateway.

The configured IP address, subnet mask and gateway on the MGMT interface are limited to the boot mode only!

The following is an example of configuring an IP address, subnet mask and gateway on the MGMT interface in the boot mode.

```
Boot> ip 10.27.41.83
Boot> netmask 255.255.255.0
Boot> gateway 10.27.41.254
Boot> show
IP          = 10.27.41.83
GATEWAY     = 10.27.41.254
NETMASK     = 255.255.255.0
MAC         = 00:d0:cb:00:0d:83
MAC1        = ff:ff:ff:ff:ff:ff
Boot>
```

Step 3
Download the new system software via TFTP using the following command.

Command	Mode	Description
load {**os1** | **os2**} *A.B.C.D FILE-NAME*	Boot	Downloads the system software. os1 | os2: the area where the system software is stored A.B.C.D: TFTP server address FILENAME: system software file name

To verify the system software in the system, use the following command.

Command	Mode	Description
flashinfo	Boot	Shows the system software in the system.

To upgrade the system software in the boot mode, TFTP server must be set up first! Using the **load** command, the system will download the new system software from the server.

The following is an example of upgrading the system software stored in **os1** in the boot mode.

```
Boot> load os1 10.27.41.82 V5924C-R.5.01.x
TFTP from server 10.27.41.82; our IP address is 10.27.41.83
Filename 'V5924C-R.5.01.x'.
Load address: 0xffffe0
Loading: ##########################################################################
         ##########################################################################
         ##########################################################################
         ##########################################################################
         ##########################################################################

         (Omitted)

         ##########################################################################
         ##########################################################################
         ##########################################################################
         ##########################################################################
         ##########################################################################
         ####
done
Bytes transferred = 13661822 (d0767e hex)

Update flash: Are you sure (y/n)? y
 Erasing     : 0x01D00000 - 0x01D1FFFF
 Programming : 0x01D00000 - 0x01D1FFFF
 Verifying   : 0x01D00000 - 0x01D1FFFF
Boot> flashinfo
Flash Information(Bytes)
Area     OS size      Default-OS    Standby-OS     OS Version
-------------------------------------------------------------
os1       13661806        *             *         5.01 #3001
os2       13661412                                4.07 #1008

Boot>
```

Step 4
Reboot the system with the new system software using the following command.

Command	Mode	Description
reboot [**os1** | **os2**]	Boot	Reboots the system with specified system software. os1 | os2: the area where the system software is stored

If the new system software is a current standby OS, just exit the boot mode, then the interrupted system boot will be continued again with the new system software. To exit the boot mode, use the following command.

Command	Mode	Description
exit	Boot	Exits the boot mode.

10.3 FTP Upgrade

The system software of the switch can be upgraded using FTP. This will allow network or system administrators to remotely upgrade the system with the familiar interface.

To upgrade the system software using FTP, perform the following step-by-step instruction:

Step 1
Connect to the switch with your FTP client software. To login the system, you can use the system user ID and password.

Note that you must use the command line-based interface FTP client software when upgrading the switch. If you use the graphic-based interface FTP client software, the system cannot recognize the upgraded software.

Step 2
Set the file transfer mode to the binary mode using the following command.

Command	Mode	Description
bin	FTP	Sets the file transfer mode to the binary mode.

Step 3
Enable to print out the hash marks as transferring a file using the following command.

Command	Mode	Description
hash	FTP	Prints out the hash marks as transferring a file.

Step 4
Uploads the new system software using the following command.

Command	Mode	Description
put *FILENAME* {**os1** | **os2**}	FTP	Uploads the system software. FILENAME: system software file name os1 | os2: the area where the system software is stored

Step 5
Exit the FTP client using the following command.

Command	Mode	Description
bye	FTP	Exits the FTP client.

To reflect the downloaded system software, the system must restart using the **reload** command! For more information, see Section 4.1.10.1.

The following is an example of upgrading the system software of the switch using the FTP provided by Microsoft Windows XP in the remote place.

```
Microsoft Windows XP [Version 5.1.2600]
(C) Copyright 1985-2001 Microsoft Corp.

C:\>ftp 10.27.41.91
Connected to 10.27.41.91.
220 FTP Server 1.2.4 (FTPD)
User (10.27.41.91:(none)): admin
331 Password required for admin.
Password:
230 User admin logged in.
ftp> bin
200 Type set to I.
ftp> hash
Hash mark printing On  ftp: (2048 bytes/hash mark) .
ftp> put V5924C-R.5.01.x os1
200 PORT command successful.
150 Opening BINARY mode data connection for os1.
################################################################################
################################################################################
################################################################################
################################################################################
################################################################################
################################################################################

(Omitted)

################################################################################
################################################################################
################################################################################
################################################################################
################################################################################
########################################
226 Transfer complete.
ftp: 13661428 bytes sent in 223.26Seconds 61.19Kbytes/sec.
ftp> bye
221 Goodbye.

C:\>
```

To upgrade the system software via the FTP server, the FTP server should be enabled on the system. For more information, see Section 6.1.11.

11 Abbreviations

AES	Advanced Encryption Standard
ARP	Address Resolution Protocol
CE	Communauté Européenne
CIDR	Classless Inter Domain Routing
CLI	Command Line Interface
CoS	Class of Service
DA	Destination Address
DHCP	Dynamic Host Configuration Protocol
DSCP	Differentiated Service Code Point
DSL	Digital Subscriber Line
DSLAM	Digital Subscriber Line Access Multiplexer
EMC	Electro-Magnetic Compatibility
EN	Europäische Norm (European Standard)
ERP	Ethernet Ring Protection
FDB	Filtering Data Base
FE	Fast Ethernet
FTP	File Transfer Protocol
GB	Gigabyte
GE	Gigabit Ethernet
HW	Hardware
ID	Identifier
IEC	International Electrotechnical Commission
IEEE 802	Standards for Local and Metropolitan Area Networks
IEEE 802.1	Glossary, Network Management, MAC Bridges, and Internetworking
IEEE	Institute of Electrical and Electronic Engineers
IETF	Internet Engineering Task Force
IGMP	Internet Group Management Protocol
IGMPv1	Internet Group Management Protocol Version 1
IGMPv2	Internet Group Management Protocol Version 2
IGMPv3	Internet Group Management Protocol Version 3
IP	Internet Protocol

IRL	Input Rate Limiter
ISP	Internet Service Provider
ITU	International Telecommunication Union
ITU-T	International Telecommunication Union - Telecommunications standardization sector
IU	Interface Unit
L2	Layer 2
LACP	Link Aggregation Control Protocol
LAN	Local Area Network
LCT	Local Craft Terminal
LLDP	Link Layer Discover Protocol
LLID	Logical Link ID
MAC	Medium Access Control
McFDB	Multicast Forwarding Database
MFC	Multicast Forwarding Cache
MTU	Maximum Transmission Unit
MVR	Multicast VLAN Registration
NE	Network Element
NTP	Network Time Protocol
OAM	Operation, Administration and Maintenance
ORL	Output Rate Limiter
OS	Operating System
PC	Personal Computer
PVID	Port VLAN ID
QoS	Quality of Service
QRV	Querier’s Robustness Variable
RFC	Request for Comments
RMON	Remote Monitoring
RSTP	Rapid Spanning Tree Protocol
RTC	Real Time Clock
SA	Source Address
SFP	Small Form Factor Pluggable
SNMP	Simple Network Management Protocol

SNTP	Simple Network Time Protocol
SSH	Secure Shell
STP	Spanning Tree Protocol
SW	Software
TCN	Topology Change Notification
TCP	Transmission Control Protocol
TFTP	Trivial FTP
TIB	Tree Information Base
TOS	Type of Service
UDP	User Datagram Protocol
UMN	User Manual
VID	VLAN ID
VLAN	Virtual Local Area Network
VoD	Video on Demand
VPI	Virtual Path Identifier
VPN	Virtual Private Network
xDSL	Any form of DSL

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